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THE ANNUAL CONFERENCE ON HIGHWAY ENGINEERING

The Conference on Highway Engineering is held annually during the latter part of February or the beginning of March by the Department of Civil Engineering of the University of Illinois with the coöperation of the Illinois Division of Highways and the Illinois Association of County Superintendents of Highways.

It started in 1914 under the name of the Short Course in Highway Engineering as a two-weeks training school for the newly-created County Superintendents of Highways. Since then its character has been changed from time to time to meet the ever-changing conditions of road building and administration in the state. In 1935 the present name was adopted.

Throughout the years the object has been to provide an opportunity for the highway builders and administrators of the state to get together for mutual acquaintance, to discuss the many problems that confront them, and to gain the latest and best information pertinent to their work. The results have demonstrated the value of the meeting, not only to those attending, but to the communities or interests they represent.

The Conference is open without fee to anyone interested in any way with improving the roads and streets of the state. The normal attendance consists of state, county, city, and local engineers and officials, road and street contractors, material and equipment dealers, and many others.

CONFERENCE ADMINISTRATION 1940

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W. C. Huntington, Head of the Department of Civil Engineering
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I. PROSPECTS FOR 1940

Charles P. Casey*

I am happy to have the opportunity of taking part in this, the Twenty-seventh Annual Conference on Highway Engineering. These annual conferences sponsored by the University of Illinois have played an important part in the development of the Illinois Highway System. Started at the time when the state was first awakening to the urge to "pull itself out of the mud," the history of the Conference has run concurrently with the history of the growth of our present-day highway transportation system. These twenty-six years have witnessed rapid change and great progress in all fields of highway activity, and the Conference has kept pace with this evolution. By affording us means to keep informed of new or improved methods, to discuss our common problems, and to become better acquainted with each other, the Highway Conference equips all of us better to perform our duties. I am sure the Conference has made a real contribution to the great advance we have made in the development of improved highways.

Speaking officially for the State Department of Public Works and Buildings, I can assure you that we are grateful for the opportunity to coöperate in these conferences. The Civil Engineering Department of the University is to be commended for the excellent record these annual meetings have established. I am sure their success must be the source of great satisfaction to Professor Wiley, who has been the guiding genius back of them for these many years.

I also want to express the gratitude of the Department to the University for the valuable contributions it has made to highway engineering through its research activities. An example of this is the concrete slab investigation for bridge floors now in process. This investigation was initiated by the Department. The University agreed to take over this investigation, and it has been conducting it with coöperation from the Department and from the Federal Public Roads Administration. When completed it is expected that this investigation will greatly simplify and improve the methods of designing concrete slab bridge floors. There have, of course, been numerous other cases in which experiments conducted by the University have improved our highway engineering practices.

I have been asked to speak to you on the prospects for 1940. I

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assume that what is wanted of me primarily is a forecast of our highway construction program for the year. As is usually the case this early in the year, there are a number of factors in the program which are not yet determined, and for that reason it is not possible to give you a definite summary of what we expect to be able to undertake. However, I will give you an estimate which is as close as we can make it now, but you should understand that this is only an estimate. In other words, I am adopting the weather man's prerogative: I am qualifying my forecast with the word "probably."

The Division of Highways began the year with contracts in force for 51 miles of high-type pavement, 22 miles of bituminous-surfaced gravel or stone roads, and 57 miles of gravel or crushed stone surfaced roads, with a total value of $4 500 000. At the same time, 47 miles of pavement, 45 miles of gravel or crushed stone surfaced roads, 56 miles of grading, 10 bridges and 9 railroad grade separations included in the federal aid programs for last year and estimated to cost $6 000 000 had not yet been placed under contract. A substantial part of these have since been put under contract, and bids will be received on the balance shortly. We have submitted to the Public Works Administration of the Federal Works Agency (formerly the Bureau of Public Roads of the Department of Agriculture) our several federal aid programs for this year, involving a total of $12 000 000 in combined state and federal funds. These provide for the construction of 91 miles of pavement, 19 miles of bituminous surfacing, 61 miles of grading, 17 bridges, and 21 railroad and highway grade separations. These programs have not yet been approved by the Public Roads Administration and are therefore subject to change. No doubt, if we assume that any program item disapproved will be replaced by another of approximately the same magnitude and character, we will not be far wrong.

The federal aid programs are based on a fixed amount of funds and we know exactly how much money we have to spend in each of them. We are not nearly so certain as to the amount of state funds we will have available for construction above those required for matching federal funds. The first reason for this is that we can only estimate the revenues we will receive from motor vehicle licenses and gasoline taxes. The second is that we cannot forecast accurately what expenditures we will have to make for maintenance, administration, policing, and additional operations other than construction. Nevertheless, our best judgment now indicates around $8 000 000 should become available during the year for financing contracts not involved

in any federal aid programs. To convert this amount of funds into certain quantities and types of construction is somewhat difficult. We have not attempted to set up a definite list of projects which we expect to finance with these funds. Despite that, we are proceeding with design work on a sizable number of projects, and as the plans for these are completed and the rights of way furnished, we expect to award contracts to the extent of the available moneys. These projects consist of all types of work. It is too early to judge with any degree of assurance which ones will reach the contract stage during the year, and it is, therefore, also too early to determine with any degree of accuracy what amount of the various types of construction we will place under contract. Yet I will make a guess at it—and I won't even claim it is an intelligent one—and say that the work to be financed entirely by state funds will amount to 65 miles of pavement, 35 miles of bituminous surfacing, 10 miles of gravel or stone roads, 65 miles of grading, 15 bridges, and 5 railroad grade separations.

Putting these sets of figures together, we get totals of 254 miles of high-type pavement, 78 miles of bituminous surfaces on gravel or stone base, 112 miles of gravel or crushed stone roads, 182 miles of grading, 42 bridges, and 35 railroad or highway grade separations, estimated to involve a total expenditure of $30 500 000. This, then, is my forecast of the work to be undertaken directly by the State Division of Highways during 1940—probably. I should like to add one qualifying remark, that the figures given represent work we hope to *undertake,* not *complete.* It is probable that not all of this work will reach the contract stage before the close of the year; and we can be quite certain that, even if we were so fortunate as to get it all contracted during the year, some of it would be carried over into 1941 for completion.

This, still, gives us only part of the picture. We know that the counties and the municipalities will continue to do their part in the highway improvement program. Here the forecasting task becomes even more complex, for we have 102 counties and some 1200 cities and villages—all distinct and independent entities—to take into account. We do know that the state allotted approximately $9 900 000 in motor fuel tax funds and 15D refunds to the counties, and $9 650 000 in motor fuel tax funds to the municipalities during 1939. We further know that the counties and municipalities completed under state supervision in that year some 1100 miles of surfacing and resurfacing of all types, 152 miles of grading, and 106 bridges. We estimate no material change in the amount of funds that the state will allot to the

counties and cities during 1940, and it therefore seems logical to anticipate that they will accomplish about the same amount of work.

Considering only the items of surfaced roads, and combining all types, our figures indicate a joint state, county, and municipal program of 1544 miles for 1940. Even if we discount this figure sharply, we still will not have cause for apology.

I am going to digress now from my subject to refer to certain other matters which I think might be of some interest to you. Because of the fact that the county is usually the agency which elects to secure right of way for state highway projects, there is probably closer contact between the state representatives and the county superintendents on right of way matters than on any other of our activities. For that reason I want to mention certain changes which have been made in our right of way policies. As you know, an increasingly large proportion of our state highway construction is being financed with federal aid. The Public Roads Administration is now refusing to concur in the award of contract for any federal aid section until the necessary right of way is completely acquired. Where only a very small amount of the right of way remains to be acquired and there is every prospect that that will be cleared by the letting date, we may be permitted to advertise for bids, but we will not be permitted to award a contract until the right of way for the section is 100 per cent clear. This new policy, which is being rigidly enforced, is slowing us up somewhat in getting work under contract, but I feel that it will, in the final analysis, be beneficial. There is no question but that we may have too frequently been over-optimistic of right of way prospects in the past. We have been anxious to get some job under contract. The county securing the right of way also wanted to see construction started, and over-estimated its ability to close right of way transactions. So we have taken bids, and by doing so have added a third party—the low bidder—to those anxious to see work start. So the contract has been awarded, but difficulties over the unsecured right of way increase rather than decrease, the contractor is delayed in his operations, and often it becomes necessary to deduct a part of the section from the contract. I believe this new federal policy is going to eliminate a great deal of unpleasantness for the state, the counties, the contractors, and the traveling public. The point of all this is, of course, that it behooves the county which is interested in seeing some state project constructed to concentrate its efforts on securing the right of way and to actually deliver before urging award of contract.

Closely related to this is the matter of the urgency for getting

our federal programs under contract more promptly than we have in the past. As you probably know, when Congress reduced the amounts of federal aid appropriations in the last authorizations, it was influenced largely by the fact that there was a large balance of previous appropriations which the states had not yet obligated by contracts. I believe Illinois was not as delinquent in this respect as a number of other states, but we, nevertheless, were partly responsible. We are making a better showing, but this situation is still not what we consider satisfactory. Our delinquency has been largely caused by delays in securing rights of way. In most cases we have completed surveys and plans for the projects involved and then have had to wait a long period of time for the right of way to be cleared.

We are going to have to adopt a rather rigid policy to correct this situation. As I mentioned previously, our new federal aid programs are now being considered by the Public Roads Administration and we anticipate approval shortly. The right of way status is good on many of the projects included, and we are hopeful that it will improve rapidly on all of the rest of them. However, if the right of way does not clear up promptly on some individual project, we will not continue to carry it on our program but will substitute some other job on which the right of way is forthcoming. Here, again, I caution the county representatives present that if our programs, when announced, include some work in their counties, and if they wish to see such work stay on the program, they must give prompt attention to the matter of acquiring the right of way.

There is one more matter on which I would like to ask the aid of those of you present outside of the Department, that is, in helping to correct the general public misunderstanding concerning our federal secondary program. There seems to be an impression that the state has a huge fund available for improving federal secondary roads. I think most of you know that that is far from the case and that, in fact, we have only about one-eighth as much to spend on secondary roads as we allot to the counties.

The mathematics of our situation is quite simple, and while most of you have probably heard the figures a number of times, I am going to repeat them for emphasis. We have $1 200 000 a year available to us for secondary roads on the basis of present federal appropriations. This includes both federal allotment and matching state money. We try to limit a single year's program to about one-fourth of the counties. Even so, we have an average of only about $45 000 to spend in each of these counties in that year. The other three-fourths of the

counties, of course, get nothing. There is no way we can increase the funds available for this purpose and our federal secondary program must therefore be fixed within these limits. I am asking your coöperation in informing the public of the true situation. I believe you can render a service both to the Department and to the general public by publicizing as much as you can the limitations of the federal secondary program.

I am quite happy to have had this opportunity of addressing you and I thank you for your attention.

II. HIGHWAYS AND THE PUBLIC

Hal Foust*

Most of us here know each other. I know my audience. You know your speaker. There shouldn't be any misunderstanding among us. I won't pull my punches. I know that you fellows can take it. You've been taking my criticism, occasionally adverse, for more than a decade. And we're still able to tip a glass or turn a card together after working hours. If you don't walk out on me, you'll get some more adverse criticism, constructive I hope, later in this paper. And I don't expect it to interfere with hotel room sociability during the rest of this session.

Before getting into the unpleasantnesses of my subject, I must thank Professor Wiley, the University and you members of the short course for letting me kibbitz at your discussions here for the last ten years. I'll also thank the professor for inviting me to appear on this program. Some of you, after hearing my paper, may neglect to thank the professor for having me here. I warned him that I wouldn't stand up here and make a Fourth of July speech, wasting your time and mine telling you that you are all nice fellows and doing a good job.

In that part of your job I have been asked to discuss—your relations with the public—you have been lousy. I try to get around a lot and keep my eyes and ears open. I haven't found anyone outside of the road building industry so pleased with his 3 cents a gallon investment in streets and highways that he wants to buy more or better streets and highways with 4 cents a gallon. On the other hand, a converse opinion is common. You too have heard remarks like these—

"We've got more slab than we use now—why build any more?"

Or "The state road system is about completed—it's time to reduce taxes."

Or "The state highway department has more money than it knows what to do with. They're planting flowers on the roadside now."

The ubiquity of these sentiments is evidence that you road builders are doing a lousy job of selling. You're collecting 3 cents a gallon from motorists but you aren't making them like it. In your engineering and construction, you may be following your best judgment in delivering in roads the full value of this 3 cents. But the public isn't enthusiastic about its part in this deal. Hard pinched as you are for dough to meet requirements of traffic, the public is against any gas

*Automotive Editor, Chicago Tribune, Chicago.

tax increase for roads. I, too, am against an up in the excise. That's your fault. Yet, like others, not in for the cheapest in transportation, I spend money for things that contribute to my satisfaction in motor travel. I will spend a cent extra for gasoline which the oil people have convinced me makes for better running of my car. Or I spend $100 for special tires because the tire people have done a better job of selling me on the idea that they give me greater safety. If you had that extra cent you could doubtless give us value received in smoother and safe travel but you haven't convinced us motorists. Couldn't Ernie Lieberman do great things if he had that extra $100 from those of us who buy them? The car builders are constantly selling us on new devices for our cars that provide safety or convenience and yet you expect us to know that you can give us perhaps greater things without telling us about them. Other evidence of your lousy selling job may be seen in the current political campaigns. Candidates of both political parties are stumping the state. If they could win votes by so doing, they'd advocate specific road programs and put price tags on these programs for the public to buy. Instead, the only references to highways I have heard during this campaign are unreasoned generalities inferring that Mr. Joe Blow as governor would give the people more than they are getting for their 3 cents.

Part of this public dissatisfaction with its part of the highway bargain is due to political manipulations in road building. Almost as responsible are your weak and faulty public relations.

My assignment here is to talk about your public relations. I hope to do more than just damn them. I hope to offer some suggestions for improving them. But I don't want to quit the reference to politics without attempting to amuse you with a recent demonstration in Chicago.

At least some of you men are acquainted with performances behind closed doors when a campaign manager edits engineering recommendations for road building. This Chicago exhibition wasn't behind closed doors, although closed-door sessions preceded it. This Chicago demonstration was in one corner of the council chambers while the council was in session.

On a table in this one corner were maps of the city showing the routes for a $207 000 000 superhighway system. Earlier in the day, the Illinois Supreme Court had invalidated a proposed method of financing the project, but Mayor Kelly, with remote control from his Miami winter home, had ordered council approval of the program anyway. The locations of the superhighways were shown on the maps

in pencil that was not indelible. Aldermen, singly and in small groups, visited the corner table while the council continued its humdrum of routine business. Charles E. DeLeuw, whom many of you remember as Mr. Lieberman's assistant, used eraser and pencil on his plans to get votes for the program.

"The ————," said one alderman, referring to his council associates, "they changed that west side location while my back was turned, but I made them put it back again so it would miss the parish in my ward."

Let's get back to the subject of public relations, and what can be done to improve them. Twenty years of newspaper work ought to qualify me to speak authoritatively from the newspaper standpoint although this trade is somewhat like astronomy in that the more you learn about it the more you appreciate how little you know. Twenty years ago I could be more confident in my statement of opinions on journalism. In ten years of specialization as a reporter of road and traffic affairs, ordinary intelligence, if this isn't boasting, should have given me a spattering of knowledge of your work. Maybe in road work I still have the audacity of the uninitiated.

I've never before had a chance to tell you men about my job, as I have long wanted to do. You ought to know more about it for the good of your industry. You ought to know more about the newspapers for the sake of your industry. Or at least you should have the counsel and coöperation of those who know newspapers.

There's a type of story appearing under my name not infrequently that is arousing resentment from some of you. It's one of those reading, in substance, "This is a heck of a note. Things are in an abominable situation. Something ought to be done about it." Or, recalling one of these yarns that might be cited as an example, we published that U. S. 40 from Terre Haute to St. Louis is a killer, and that it should be rebuilt as a superhighway; Indiana and Ohio are doing extensive work in modernizing this route; Illinois is lagging.

Now I know, without his telling me, that Mr. Lieberman would like to rebuild U. S. 40; I also appreciate that available funds are not unlimited; I also appreciate that there are right of way difficulties; I also appreciate that there are some political difficulties with communities disputing the best engineering for the location. I'm not sure that Mr. Lieberman appreciated that that cannonading line about U. S. 40 would help him get public support to rebuild U. S. 40.

I'll leave it to your judgment as newspaper readers rather than newspaper writers. Do you think in discussing U. S. 40 I should have

laid emphasis upon apologies for the delinquency in Illinois? Do you think that would have been a more effective way of attracting public attention to the dangers and inadequacies of U. S. 40? If you think soft music and pansies arouse the public to action, you don't know your public.

Unless there is a continued hammering for a betterment of pavements, you folks who get your beans directly or indirectly from motorists' taxes might as well find other jobs. The public won't continue to pay 3 cents if improvements aren't needed. If you were to follow the advice of a public-relations counselor, your voice would be louder than mine in damning present streets and highways and yelling for improvements. Instead, there's a disposition to resent my yelling.

As far as I am concerned, there isn't anything personal about this. I fought with Emmerson almost as much as I have fought with Horner. Frank Sheets, the former highway chief, caught printed hell for his brick resurfacing and for his failure to lay the dust on short and temporary detours, just as Lieberman has caught hell for not concentrating his expenditures on the old roads where deaths and traffic are concentrated. Ernie shouldn't feel that I'm agin him. I'm for better highways and it's a newspaper man's viewpoint that the best way to get them is to get the public to shout for them. Disputatious articles may tread on some toes but they are necessary to awaken the public.

I know that many of you men in the road building business have varying degrees of sympathy for my attitude. Were this not true, I might have had a little difficulty in getting some of my news after a certain letter was sent to all the state's district offices a year or two ago saying that no information should be given to Hal Foust; that all road news should be released through the Springfield press agents. I got my news, and none of my informants suffered any unpleasant consequences.

Why should there be this attempt to muzzle state employees? An explanation, if not the real reason, is that there should be no conflict in statements of the administration's policy. No newspaper man wants to get a news source in bad with the bosses. But if I want to learn something about how a maintenance crew handles a plow in a snow storm, I want to talk with the maintenance men, preferably during a storm—as I did this winter. I don't want to get a release from a publicity office, approved by the chief engineer, quoting Governor Horner as saying that the maintenance men work hard on plows to remove snow from the pavements as part of the governor's state-wide

safety program. Of course I'm not going to quote the plow chauffeur on Department Police.

I'm trying to make two points in this illustration. First, the best story of a particular operation comes directly from the operators. They know the most about it. Instead of being gagged, highway department employees, each an expert in his line, should be encouraged to disseminate information about their jobs. This would tend to dispel a prevailing ignorance of your road problems, a public ignorance that is your main problem in tackling a construction program in future years that should be bigger than any that has been undertaken in the past. Secondly, too much of your publicity and public relations efforts have been directed for political effect. A newspaper editor, receiving an announcement of the award of a paving contract, puffed with praise for the Governor's wisdom and beneficence in spending $25 000 of taxpayers' money on a certain job, may overlook the news story hidden by this political propaganda. This publicity policy tends to hide news that would be good propaganda for highway construction, the story of the benefits to motor transportation in excess of the $25 000 that the motorists are paying for the improvement.

So that you won't suspect that my opinion of the present Springfield administration is influenced by irrelevant prejudices, I want to say something tough against the Republicans who were in power when I became automobile editor. Frank Sheets became a good public relations man after he left the Highway Department and went to work for the Portland Cement Association. As an example of his weakness in public relations while under the orders of a Governor, I failed from July of 1929 until he left office in 1932 to get him to issue his announcements of the letting of a contract in a form that meant anything. He would inform newspapers that bids were to be received on sections 287B-288C and 421A of S.A. 157 and on sections 27 and 68 of SB 24. Imagine a housewife or a streetcar conductor getting high blood pressure on reading those unintelligible symbols. Of course they wouldn't read it because the chances are that no newspaper would take the time and trouble to find out what it was about. On the other hand, these numbered sections may have disguised the identity of a death curve familiar to a community, and a proper presentation of this information to the newspapers might have rated an item that would tend to promote an intelligent appreciation of a highway betterment. And in this item, you wouldn't have to mention who is Governor at the time. The public knows who is Governor . . . . or at least the public has known prior to the present peculiar situation in Springfield.

In conclusion, I may repeat myself for the sake of emphasis. You know better than I that your financial and physical problems in building a highway system for the future, yes, and aid for the present traffic too, require a sympathetic coöperation from the public. Ignorance breeds suspicion rather than sympathy. Educate the public. Give them all the information you have. As long as I am on the present assignment, I'll do all I can to get the public interested and informed.

Before closing, I must mention that I am not appearing on this program with authorization to represent the Chicago Tribune. The newspaper is responsible for what I write therein; I alone am responsible for what I have here said.

Thank you, Dr. Wiley, for inviting me here. Thank you men for listening. If any of you want to throw bricks, ask me questions, heave away.

III. THE STATUS OF PROFESSIONAL ENGINEERING REGISTRATION IN ILLINOIS

HAROLD E. BABBITT*

Personal interest, if nothing else, requires that every professional engineer in Illinois follow the progress toward registration in this state in order that his interests may be represented if and when legislation for the registration of professional engineers is enacted. To some engineers both public and professional interests, in addition, demand personal attention, participation, and support of proposed legislation. The registration of all professional engineers, according to the March, 1940 issue of the American Engineer, is now required in forty-five states, and the registration of structural engineers alone is required in Illinois. Only New Hampshire, Wyoming, North Dakota, and the District of Columbia permit unrestricted practice. In Illinois, sentiment is strong among many branches of the profession that all branches of the profession should enjoy equal privileges and responsibilities. The most active opposition to the registration of professional engineers has been found in organized labor, based on the ungrounded fear that legislation of the type attempted to date would run contrary to its interests.

It is not the purpose of this article to debate the advantages and disadvantages of professional engineering registration, but it should be emphasized that one desirable feature upon which proponents and opponents agree is the need for bringing Illinois into harmony with her neighbors so that both the public and the profession may be protected against the practice of engineering by unqualified non-residents of the state, and to provide the privileges of reciprocity in other states to engineers residing in Illinois.

Most engineers are acquainted with one or more of the so-called "model laws" for the registration of professional engineers, approved by various national, state, and local professional engineering societies. Some are not acquainted with the fact that there are more than one of these model laws, and that their requirements are not completely in harmony. The question most commonly asked by the engineer first showing interest in the question of professional registration in Illinois is, "Why don't we adopt the Model Law?" The answer is simple; there is no model law on which the profession has agreed, and none

*Secretary-Treasurer, Illinois Society of Engineers, Urbana.

of the model laws is in harmony with the Civil and Administrative Code of Illinois.

The first move leading toward the adoption of legislation for professional engineering registration was made in Illinois in 1933, before the Fifty-seventh General Assembly, following the adoption, in 1932, of "A Model Law for the Registration of Professional Engineers and Land Surveyors." This model law was later revised in 1937 and presented before all national, state, and local organizations of engineers for the widest possible discussion. Results of the attempt to secure the passage of this model law by the Fifty-seventh General Assembly in Illinois included the discovery of the incompatibility of its terms with the Civil and Administrative Code. The amount of time required to make the necessary alterations and to secure the approval of interested organizations was so great as to discourage further progress in this direction before the Fifty-seventh General Assembly.

Following the failure of the "Model Law" of 1932 to make progress in the Fifty-seventh General Assembly, there was introduced into the Senate a bill for the registration of civil engineers. This bill passed the Senate unanimously and was making good progress in the House when it was caught in the jam at the end of the session and lost for want of time to attend to it.

House Bill No. 895, also calling for the registration of civil engineers, was introduced into the Fifty-eighth General Assembly by Honorable A. M. Kaindl. This bill felt the first touch of the powerful opposition led by the Building Trades Council of the American Federation of Labor of Chicago. This opposition was so well organized and took the proponents of the bill so much by surprise that effective progress could not be made against it, with the result that the bill died in committee. Attempts to arouse sufficient support among professional engineers to carry the bill on to its passage, despite the opposition, revealed a lack of unity within the profession itself. Opposition was *openly* based on the fear that the passage of the bill would prevent operating engineers from pursuing their means of livelihood. Unannounced motives, of a sinister nature, detrimental to the interests of both the public and the profession attracted others into opposition to provide the most outspoken of its leaders.

Unity among professional engineers was attempted in the interim between the Fifty-eighth and Fifty-ninth General Assemblies through the organization of an independent committee of professional engineers under the chairmanship of J. A. Harman of Peoria. This com-

mittee labored diligently for two years to unite engineers in drawing up and supporting a satisfactory bill, and in meeting the objections of the opposition. The open objections were satisfactorily met by inserting into the bill wording suggested through the courtesy of J. G. Bennema, Treasurer, Local 143, Union of Steam and Operating Engineers; International Secretary, Legislative Committee, Illinois State Federation of Labor. The work of the committee failed ultimately because the committee had not met the objections of the unspoken influences misusing the strength of organized labor for its selfish interests. The nature of these influences were not recognized until the campaign before the Sixty-first General Assembly in 1939, and even then they were not fully appreciated until it was too late for the campaign to be successful.

Honorable I. A. Palmer, of Herrin, introduced House Bill No. 508 into the Sixty-first General Assembly on March 21, 1939. Speaker Cross and Mr. Palmer should be commended for their success and judgment in referring the bill to the House Committee on Education, of which Mrs. Lottie Holman O'Neil was Chairman. A few, too few, professional engineering societies started a campaign in support of the passage of the bill and, at the same time, the Building Trades Council of the American Federation of Labor in Chicago began a vigorous campaign against the bill. The Chief Engineers Association of Chicago, an association of operating engineers whose principal duties are the operation of the mechanical equipment of large buildings in the city, filed a protest with the Committee of the House asking delay on House Bill No. 508. The opposition was led principally by Mr. Wm. H. Free, President of the Chief Engineers Association, and Chairman of the Legislative Committee of the Chicago Building Trades Council of the American Federation of Labor. Among the most outspoken opponents of the bill was Mr. James Gilboy, Business Agent of Local No. 14 of Technical Engineers, Architects, and Draftsmen's Union of the American Federation of Labor. Professional engineers supporting the bill appeared before the Legislative Committee of the Chicago Building Trades Council, and tried by logical reasoning to meet the outspoken objections. Their task was unsuccessful, obviously because of the fear and suspicion expressed by members of the committee that the proposed legislation was a selfish attempt by professional engineers to obtain an ascendency over operating engineers of a stifling nature similar to the declared unfair advantages gained in such states as New York and Florida.

On April 19, 1939, House Bill No. 508 was called up for public

hearing in the Capitol at Springfield. So strong was the opposition that Honorable Jack Palmer asked that a sub-committee be appointed to work out a compromise between the proponents and the opponents. The sub-committee, composed of representatives Palmer, Sprague, Vacco, John Rayon, and Garman met in the Builders Building in Chicago on April 24. A small group of professional engineers spoke in favor of the bill. Opposition was represented by more than 50 representatives of labor organizations, and by representatives of various professional engineering organizations. The impossibility of securing harmony was so apparent that Mr. Palmer appointed a committee consisting of representatives of most of the groups present, under the chairmanship of Mr. Wm. McGuinneas, President of The Electrical Contractors Association of Chicago. This committee, hereafter called the Palmer Committee, organized and made plans for its next meeting on April 29, 1939.

At its meeting on April 29, 1939 the Palmer Committee was unable to make progress other than to adopt, unanimously, a resolution to the effect that the committee was favorable to the principle of professional engineering registration. To expedite the work of the committee a sub-committee, composed of James Gilboy, B. C. McCurdy, and H. E. Babbitt, as Chairman, was directed to prepare a compromise bill satisfactory to the Palmer Committee.

The sub-committee reported to the Palmer Committee on May 20. Two bills, neither of which were satisfactory to anyone, were presented for consideration. The hopelessness of the situation, in view of the short time before the adjournment of the Legislature, was apparent to all. Desiring not to lose the ground already gained toward an understanding between all concerned, the sub-committee was directed to continue its efforts and, when a satisfactory bill had been prepared, to call the Palmer Committee together for its consideration and action. The sub-committee is at work. It is expected that a satisfactory bill will be prepared and presented to the Palmer Committee some time during the fall of 1940.

In the meantime the Legislative Committee of Illinois Engineering Council, under the chairmanship of T. G. LeClair, has been active. This committee has prepared and will distribute to the executive officers of various professional and other interested engineering societies throughout the state a tentative draft of a bill for their consideration, with the request that suggestions leading to the improvement of the proposed draft be submitted to the committee on or before May 10, 1940. It is expected that the Legislative Committee of Illinois

Engineering Council will formulate these suggestions into a bill satisfactory to all concerned. A proposed bill will probably be drafted by the Legislative Committee of Illinois Engineering Council and will be submitted this summer to the various engineering societies for their consideration and approval. It is to be hoped that the Palmer Committee can be among those joining in the approval of Council's bill, and that all factions can join in united support of a bill before the Sixty-second General Assembly, which assembles in January, 1941.

IV. THE PROBLEM OF TRAFFIC CONTROL*

Robert E. Daggett†

Traffic control is a science that has been created in recent years. From its beginning it has grown constantly, through necessity. Its importance is shown conclusively in the development of every community.

Experience in this field is very limited because most of the development of traffic has occurred during the past twenty years. There has not been a great deal written on these problems, and most of the work is original study.

Traffic control is no longer strictly an experiment. It is a dire necessity. Every community which tends toward development and progress must, first of all, solve the problem of traffic control, or content itself with being on a declining grade.

Viewpoints on these problems differ greatly. Most of them are based on sound engineering reasoning, but they are characteristic only of their particular environment. A few fundamental principles are universally followed in practice, but the problem is very elastic, and should be studied with the greatest of care. Safety and convenience should be the controlling factors in all design.

The great flows of population in every market, expressed as traffic, are produced by two fundamental necessities of life. The first is the necessity to work. This is the primary motivation of the great mass of daily population movements. People must leave their homes to produce, or to buy and sell in the market. The second motive is social and intellectual. A substantial part of the daily movement of traffic is occasioned by recreational, social and educational necessities.‡

Traffic flow is normally composed of different classes of traffic in varying proportions. The proportions of the various classes—pedestrian, automobile, truck, and mass transportation traffic—vary with the location, size, and physical characteristics of the city. Weather conditions affect traffic considerably.¶

Miller McClintock states in his book on Traffic and Trade that, "In any city, the central business district usually contains a combination of large volumes of all classes of traffic, while in the residential areas the volume of vehicular traffic usually predominates. On certain

*Student prize paper.
†Senior student in Civil Engineering, University of Illinois.
‡"Traffic and Trade," Paver and McClintock.
¶*Ibid.*

routes large street car volume is found, on others large truck or bus volume. Pedestrian traffic has a tendency to attain a significant volume only in business, shopping, or recreational areas."

In any discussion on traffic control there are almost as many problems to be considered as there are reasons for their correction. Each condition is a problem in itself and, in most cases, is not comparable to any other.

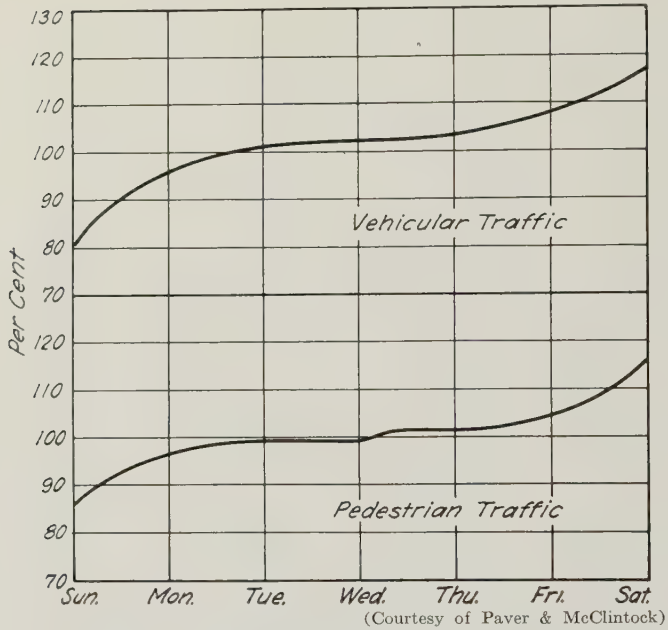
The study of traffic control is usually limited to a realization of the blunders we have made in the past, and to the correction of these mistakes only after unnecessary fatalities have occurred. Of recent years the traffic problem has become so acute as to be one of the most serious of engineering problems. We do not need to go any further than our own home town to realize the necessity of improved traffic conditions.

Most of the traffic thoroughfares in any city today are laid out upon streets which were never meant to carry such volumes of traffic. It was difficult to foresee any such development in vehicular traffic as has been reached during the past twenty years. In 1930, private automobiles reached the peak of 400 billions of passenger miles—more than eight times as many passenger miles as for any other mode of transportation, and four times as much as for all other modes combined.

The problem of traffic control can be considered as threefold, including (1) the correction of present traffic hazards, (2) the study of and careful development of traffic conditions in the future, and (3) an educational program for the pedestrian traffic to meet present conditions. Of course, many other problems could be added to this list, but these are the basic interests in all traffic problems.

As Mr. G. G. Kelcey states in "Traffic Engineering," one of the fundamental principles of traffic control is that, when traffic intersects at a right angle, there is no confusion. He states, "Observe the steady stream of pedestrians and automobiles intersecting at the cross walks of a busy corner. Pedestrians do not act nervous or excited if they cannot get all the way across. They stop and allow automobiles to pass them, with but a foot of clearance. There is no confusion. There is just one direction in which to look for trouble and it is easy to judge direction, distance, speed and clearance."

Intersections not meeting at right angles form zones of confusion which are dangerous to both motorists and pedestrian. Why? Because it is impossible for either the motorist or pedestrian to judge accurately distances, directions, speeds or clearances. This problem is clearly



(Courtesy of Paver & McClintock)

FIG. 1. TYPICAL CURVES SHOWING RATE OF TRAFFIC FLOW BY DAYS OF THE WEEK

portrayed by a man crossing an intersection diagonally. He must watch in all directions at once and a human being cannot react to all his impulses simultaneously.

Mr. Kelcey says, "When traffic is obliged to make a right-angle turn, over 90 per cent of the accidents are eliminated" because (1) speed must be greatly reduced to make the proper turn and, therefore, traffic is under easy control, (2) all traffic intersects at a right angle; there are no areas of confusion; each pedestrian or motorist automatically takes his turn.

If all vehicles could travel in the same direction and still reach their destination the accident problem would be largely solved. According to reliable information, circular traffic introduced at an intersection in Los Angeles handled as many as 2949 vehicles an hour without the aid of a traffic officer. Accidents were reduced from an average of 12 per month to 2 per month, a reduction of 83 per cent.*

In any large street areas, traffic should be limited to definite lanes. A pedestrian trying to cross such a street becomes highly confused if the passing traffic is moving in all directions.

*"Traffic Engineering," G. G. Kelcey.

No motorist deliberately crashes into a fixed obstruction in his path. His carelessness is shown in not expecting or looking for the obstruction. Mark fixed dangers unmistakably, and even the worst carelessness can be overcome.*

Traffic accidents can be prevented. To do this it is necessary to prevent "jay walking" and to educate the public in proper driving. Pedestrians should be subjected to much the same control as vehicles. The intermingling in the roadway of pedestrians and automobiles retards traffic and is one of the major causes of accidents.†

Safety zones for pedestrians crossing crowded streets and for passengers of street cars contribute to keeping the accident rate low. Traffic signalling is another important measure which, if properly applied, safeguards public life and property.‡

Development of regulations to handle future traffic conditions requires the use of common sense in the basic plan and the continued modification of this plan to suit changing traffic conditions.

It is impossible to set any definite rule to follow for all conditions. Any such rule would prove to be both impractical and inadequate as many of our earlier predecessors have found. Experience, of course, is the best teacher in any field, and it is fortunate that the experience of others is available as a background for study.

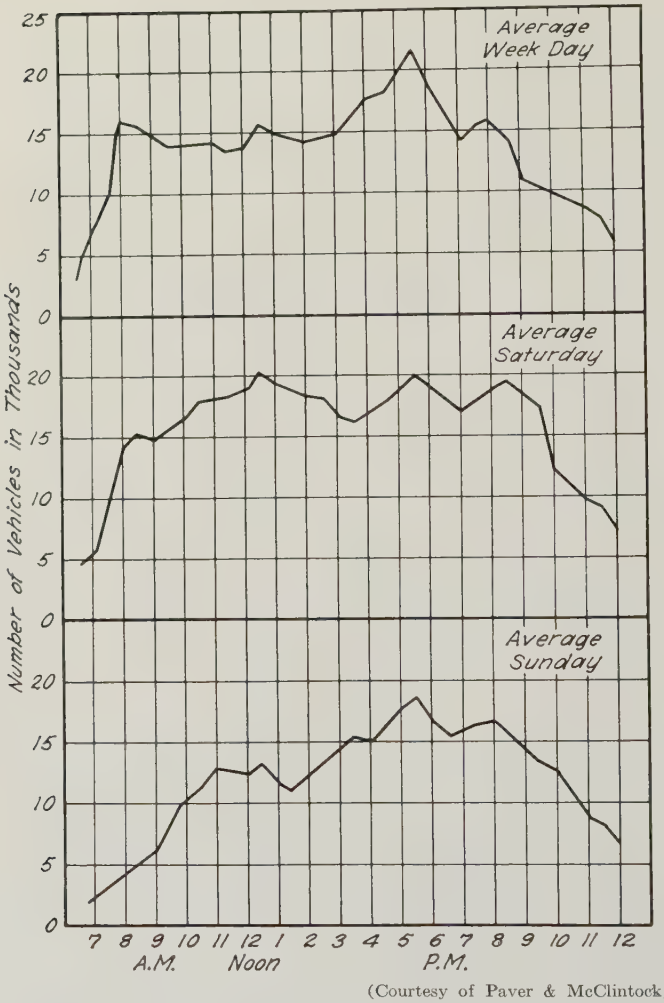
Methods of traffic control depend principally on the type of traffic handled, the area of service, and the topography of the district.

In the past, there has been needless delay to through traffic by passing main highways through congested areas. The result of this practice has been a sorrowful lesson to many engineers. A number of years ago, many communities sought to have the proposed Lincoln Highway, a coast to coast route, pass through their business districts. As the years passed these same communities wanted the Lincoln Highway to by-pass the heart of their downtown districts. A study of traffic conditions shows that 20 to 30 per cent of all traffic on main highways is through traffic.

"A city's development is conditioned upon that city's capacity to provide fluid transportation, and a city's development will stop when the point of traffic saturation has been reached. The upward trend of development of many cities is already beginning to show a tendency to flatten because of congested and delayed transportation," state Cheney and Kelcey in their paper on "Traffic Improvements."

Main highways should be placed along the outskirts of the city and

*Ibid.
†"Traffic Improvements," F. E. Cheney and G. G. Kelcey.
‡Ibid.



(Courtesy of Paver & McClintock)

FIG. 2. COMPARISON OF VEHICULAR TRAFFIC THROUGHOUT THE DAY FOR DAYS OF THE WEEK

branches should lead to the business districts. For several years now automobile clubs have been routing tourists traffic so as to avoid congested districts.*

Parking facilities have always been a serious problem for engineers. A number of suggested remedies have been tried—some satisfactory and some not so successful. Here again, the type of traffic is the most important item. Each community is a problem in itself and

*"Traffic Improvements," Cheney and Kelcey.

its solution depends upon the characteristics of the district. Parking of cars on roadways is an evil that must be met. If conditions exist whereby parking can be done off the thoroughfare and still in a convenient location, the parking problem is solved. However, this is seldom the case. When less favorable conditions arise, we must choose the lesser of two evils, and solve the parking problem in the most practical and convenient manner.

Main intersections should be well lighted, as over 40 per cent of all accidents happen at night. The installation of traffic signals should be done only after the necessity for such has been determined by careful study. Many times these signal lights prove to be more of a hazard than a help in solving traffic problems. Restricted left hand turns have always been a pet toy of many engineers. A corner with a "No Left Turn" does not necessarily reduce the amount of left turn traffic. It simply redistributes it and tends to congest some other intersection.

An educational program for the general public on traffic conditions seems to me to be the most practical, efficient and economical remedy for our traffic problems.

Mr. Kelcey states, "In Traffic Engineering, aside from the movement of traffic, there is a decided human factor—the man at the wheel. The majority of motorists do not realize that they are not driving properly. Traffic violations are rarely wilful. Some of the greatest causes of accidents look quite harmless from behind the wheel. It is largely a question of judgment as to safe speed, whether the next car will unexpectedly cross your path, or whether your car is under sufficient control to meet an emergency."

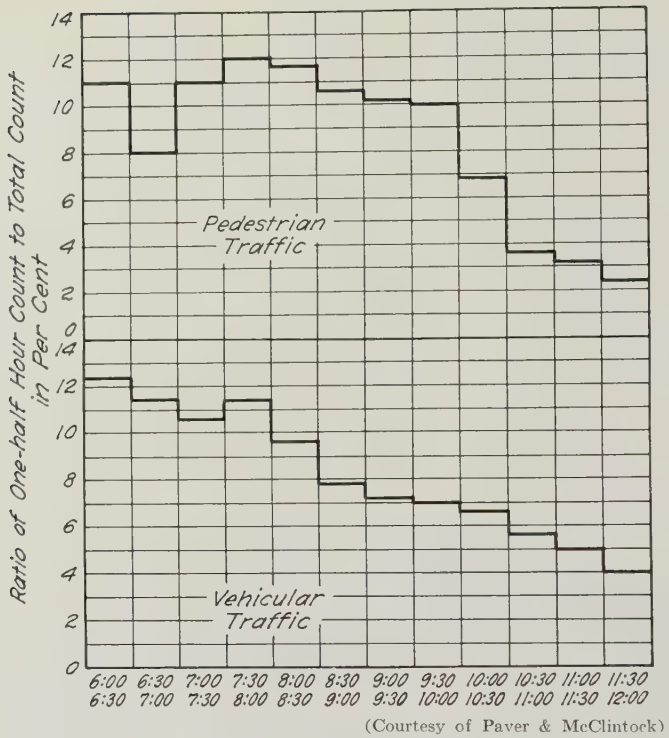
Carelessness in driving becomes a habit in an individual. When we drive hurriedly we usually form poor habits for safe driving. Repetition of these faults, without accident, leads us to believe we are driving correctly and when an accident occurs, we are most surprised.

Any educational program that will tend toward better driving by the motoring public is an essential feature of every attempt to reduce traffic accidents.

Experienced drivers are safest. For example, for each 100 000 000 vehicle miles in Chicago in 1923, taxicabs killed 22, trucks 27, and passenger vehicles 67. This proves the value of experience in driving.*

How can these safety programs be accomplished? There are several ways. Licensing drivers, as is done in many states, is a progressive step. Compulsory inspection of all motor vehicles by competent

*"Traffic Improvements," Cheney and Kelcey.



(Courtesy of Paver & McClintock)

Fig. 3. Typical Night Traffic Flow Based on One-Half Hour Intervals

mechanics should be made at regular intervals. A driving school, taught by trained instructors, could be used to train all beginners. Those guilty of reckless driving should be required to obtain a permit from this school in order to regain their licenses. Heavy fines should be exacted from all those found guilty of driving while intoxicated. And, lastly, literature, published monthly or at regular intervals, describing traffic conditions of the district and the surrounding main traffic arteries leading to the city, should be distributed.

These are but a few of the ideas that should be incorporated in safety programs. Some of these already have been successfully tried in some communities. Whatever the idea to prevent accidents is, it is worth while if it will save lives. There are more people killed yearly by automobiles in the United States than were killed in the American forces of the World War. Accident prevention is a dire necessity. Those of us who have experienced such a tragedy in our lives realize the necessity for a cure. If we are to continue to call

ourselves a civilized nation, we must eliminate this barbaric killing of human beings, and strive for a safer environment in which to live.

As Cheney and Kelcey state in their paper on "Traffic Improvements"—to summarize briefly, there is no single key that will unlock the mysteries of traffic.

A sane application of common sense will point the way to a solution of traffic problems.

Properly installed traffic signals prevent accidents. Traffic signalling poorly done often makes matters worse.

By-passing through traffic is highly desirable, and invariably works a benefit to the retailer.

The problem of parking is elastic, and the solution must be made to conform to the situation. The most benefit to the greatest number of people should be the governing principle.

Our present streets were never laid out nor built with any idea of the amount of traffic they would be called upon to carry. Consequently, many of them are inadequate and unfitted to handle the situation. But we are forced by circumstances to use to the best advantage what we have, so that the immediate problem of every municipality is to do all that can be done to fit traffic to present streets. The ultimate solution is to fit streets to traffic, and all work with traffic should be directed toward this end. Much of value in regard to traffic control is being developed, and it is generally felt that real progress is being made, and that some fundamental principles are being established which are proving to be scientifically correct.

The work so far has been mostly with main arteries of traffic. These routes carry the heaviest traffic and, of necessity, require the first assistance. It is difficult to make drastic changes rapidly. The progress is slow, but the improvements have been justified by results.

Recent experiments have proven to be quite successful, and it is through experience gained therein that further improvements have been planned for the lesser important routes of our communities.

What has been accomplished in the past is only a mere scratching of the surface. The problem of traffic control has become so important in recent years that it can no longer be neglected. This problem must be met and a solution found that will handle the present conditions in a more suitable and adequate manner.

The problem can be solved only after much thought and consideration. It is not as simple as applying a formula and solving for the result. Special formulas must be devised where necessary. Each ques-

tion must be tackled from a particular viewpoint and after an intelligent analysis. A merely temporary relief should not be the object. Conditions to be met in the future should also be considered, as this is of utmost importance. No present solution is satisfactory if it will be found to be inadequate in a very short while.

Future conditions can best be predicted by (1) a study of the amount of present traffic and the amount of increase expected after the proposed present improvement; (2) the amount of growth in population to be expected in the specific district; (3) the type of traffic to be handled; and (4) the returns to be expected from the improvement in regard to safety, convenience, and business.

What is necessary is simply the use of judgment and good common sense in all design. Most people are likely to believe that the solution of engineering problems is usually very complicated. This is not the case at all. Sound engineering practice is simply the elimination of troubling conditions in the most convenient and adequate manner. Many times the most simple type of improvement is the best solution possible.

Traffic control is in its infancy. It needs development and study just as much as many other engineering problems. Your suggestions and mine, your problems and mine, your solutions and mine may some day help to correct the faults which we, today, encounter.

Future development is just as dependent on transportation facilities as it has been in the past. Progress in other fields will be hindered by failure in the field of traffic control.

The field for development of traffic control is open wide. It is a problem that will always remain with us. It needs intelligent men, working together with but one object—the object of all engineers—a safer and a better place in which to live.

V. LOCAL ROADS AND THE HIGHWAY PROGRAM

M. C. Jones*

State, county, and township highways are of three separate and distinct types, and are all used for the same purpose, transportation, but are supported and maintained under entirely separate organizations. Being a township highway commissioner, I am not familiar enough with the State and County Highway organizations to enter into any discussion on them, other than to make this statement: we are all spending the taxpayers' money, and under these conditions should make every effort to coöperate with each other, and above all things, not forget that we are also public servants. One thing we do have in common is drainage, the first and major essential of any highway, because no road, regardless of kind, will remain permanent with water on each side, and over it. I really do not believe too much thought can be given this problem. I find the best way to handle surface water conditions is to travel my roads immediately after a heavy rain. In this manner one actually sees the situation at its worst, and this gives a very good idea as to what must be done to get rid of the water by open ditches and piping. Of course drainage is an engineering problem, and if at all possible, should be handled as such. I do not believe there is enough coöperation between the three divisions on drainage, because I have seen many instances where the highway commissioner could drain the water from a state or county road, with very little effort, and vice versa, and all three be benefited. In doing this, you will also notice that some farmer has been benefited, and, from what I have seen and heard, the farmer has not always been given as much consideration as he should have received. In giving him proper consideration, it will be made possible for him to raise a better crop, which in turn, helps out in his tax problem.

The great network of state and county highways, along with the automobile and truck, has made the duties of a township or road district highway commissioner, very complex, because he must produce a good smooth surfaced road, free of dips and bumps, the year round. Since a lot of these roads are dirt, and some of them oil treated, it is a real problem. Especially when there is no more money available now than in the "good old days" we hear people talk about. I don't know what it costs the state and county for maintenance purposes, but

*President, Illinois Association of Township Officials, Tuscola.

I do know many highway commissioners produce pretty good roads, ranging in cost from ninety to one hundred and fifty dollars per mile, and not many of the latter. This cost includes all equipment, labor repairs, ditching, and supervision. The state and county have four sources of revenue; namely, license, gas tax, federal aids, and a county levy, while the township has only one regular road and bridge levy, with a maximum placed by law. Some have special oil levies to purchase road oil. Due to low valuations, numerous townships, and even counties, cannot raise enough money through these fixed levies to keep their bridges in repair. Something should be done to change this situation.

There are any number of things a highway commissioner has to contend with, namely, maintenances, finances, and public demands, making his problems, I think, more complex than those of any of the other highway organizations, and more advantage is taken of him than of either the state or county. To start with, the public is more demanding of him and, since he is an elective officer, he must either come through, or be beaten at the next election. The county superintendent of highways and the state do not have this situation to meet, because all jobs are appointive. No two commissioners can work their roads alike, because they seldom ever have the same type of roads to work, due mostly to various types of soil; a number of them have gravel roads, a few black top, others have earth and oil-treated roads, and others just plain old fashioned earth roads. The commissioner with gravel roads can, to a certain extent, outline his maintenance problems, if he has the finances available, but, as has often been the case, when a bond issue was voted for gravel roads one of the most important items was overlooked, equipment to properly maintain them. As a result, we find many gravel roads over the state in a run-down condition, bringing the wrath of the public down on the commissioner. Another thing in making gravel road that is overlooked is an adequate supply of gravel to continue maintenance. As a result, I believe, from experience, that an oil-treated road will prove more beneficial in the end, and reach more people. The commissioner with oil-treated roads has an entirely different, and maybe a little more expensive, problem. Oil-treated roads are not permanent, and may be completely ruined by any number of things, such as snow, fog, lug tractors, moving of buildings, narrow-tired wagons, and heavily loaded trucks, but can be so arranged that every farmer in the township will have at least one way out. The maintenance problem is just about the same each year, ditches must be cleaned out to

insure proper drainage, and this dirt worked down on the shoulders; the old oil must be scarified and worked down, at the same time, bringing in some new dirt. After this has been done a great many commissioners start oiling; however, I believe it to be a good idea to go over these roads at least twice with a two-way drag and circle. In doing this, you are able to get a smoother surface, and fill any holes that happen to appear. When I start to oil, I use a reversible two-way drag to remove all loose dirt and dust, just ahead of the oiler. In applying the oil, I spread two thousand gallons per mile, eight feet wide, and twenty-five hundred gallons, ten feet wide, applying two coats; this procedure with very good success; at least my farmers are very well satisfied. After the oil has been spread most of the maintenance work for the year is ended, unless we have snow. This, if let stand on an oil mat, will almost completely ruin the road, because snow water seems to soak through the oil, causing it to rot, which in turn causes the road to rut up and become almost impassable. Consequently, I do not believe a commissioner can spend too much time removing the snow, all the way back to the ditch line. Foggy weather is equally as bad, especially when heavy loads are moved over the road, because an oil mat is nothing more than a scab on the earth surface. This scab becomes soft during foggy weather, and will slip, or move when a heavy load goes over it, with the same after effect as produced by snow.

Many counties employ the highway commissioner to maintain their county roads, which of course, means their problems are very similar.

The public demands for better roads, larger bridges, and pipe for farm entrances, along with W.P.A., has placed the financial condition of most road and bridge funds in the red, and some method must be worked out to relieve this situation. A great amount of valuable work has been done with W.P.A. labor; however, to get this labor, each commissioner has been forced to contribute twenty-five per cent (25%) of the cost of the project. This accounts for many townships being so far in the red that they will never get out. Now that the saturation point has been reached, many commissioners are wondering what to do next. They can't apply for new projects, because there is no money for the sponsor's part. Many others are becoming dissatisfied because they cannot use the men as they see fit. In fact, one county passed resolutions to cease all W.P.A. labor on their county and township roads, effective April 1st, unless they could use W.P.A. labor as they saw fit. They presented the resolution in a body to

their W.P.A. office, and were informed nothing could be done about it, as their instructions came from Washington. This seems to be the cry all over the state. While the purpose of W.P.A. was for temporary relief and for the unemployed, it has reached the stage where it appears to be a permanent fixture, in some form or other. As a result, I believe it would be a good idea for each county and township to adopt this plan, and also even cities and villages, and by so doing, a great many of their street and alley difficulties would be relieved. Something should also be done about the management. As it stands today, it is nothing more than a centralized labor problem, and I believe it could be handled more efficiently through local management, or at least through men who know more about roads and bridges than the majority sent out today. This may be out of order, nevertheless I want to ask you this question; not for an immediate answer, but to take home for consideration. With W.P.A. as a sample of centralized labor, what would centralized township government be like? While on the subject of centralization, I might say we have something similar in our State Highway Department. I understand they hold council between themselves, relative to forms, specifications, etc., upon the building of county, or state-aid roads, and bridges. Then when the county superintendent presents a road program for improvement, he must adhere strictly to their rules, regardless of cost. It is true, there must be some uniformity, or it would be a mess; however, I believe all this could be rectified, and a lot of money saved if the Highway Department would let the President of the County Superintendent's Association pick a committee of not less than three, nor more than five, to meet with the State Highway Planning Board. Each time they met, not only would money be saved, but I firmly believe there would be a lot more harmony.

One solution to the financial situation is to change the levy laws, if at all possible, so the highway commissioner could, if need be, make a 33¢ levy without the consent of the Town Board, and a 33¢ to 50¢ levy with Town Board approval. Bond issues would not do, because on expiration date they would have to be voted again. If a county, or counties, were in like circumstances, their 12½¢ levy should be raised to twenty or twenty-five cents. An increase in the gasoline tax might be of great help. This, of course, would not meet with the approval of the oil companies, and would require considerable sales propaganda to sell the idea to the public. It might be, the assessor could, if he would help us, relieve some of our tax problems, especially if he were more thorough in taking the assessments; one

thing is sure, if he doesn't improve pretty fast, he is going to be without a job, because the Tax Commission is complaining and has even gone so far as to suggest a county assessor, which I don't believe we need nearly as much as we need the infliction of a heavy penalty for failing to make out our schedules as they should be. As things stand, I think the change in the levy laws the most practical solution, from a county and township point of view.

We find a large number of miles of gravel roads in this state, built through the aid of bond issues, and W.P.A. labor. And I ask you, how many of these roads really meet the public demand, other than to keep them out of the mud? Not many, because the state called it an emergency, and let the bars down on requirements and specifications; the gravel is rarely, if ever, spread thick enough to last the life of a bond issue, very few of these roads are wide enough for two cars to pass, and the dust hazard is terrible. The Rural Mail Carriers Association of Illinois made a survey, and found that a great percentage of these gravel roads were worn out and badly in need of repairs, because the highway commissioner used poor judgment in his bond issue finances. He did not figure on the proper equipment to maintain them, and most important of all, did not figure on having an adequate supply of gravel on hand to make the necessary repairs. All these things being true, how can you expect to make a good black top job?

Since conditions and times are demanding more and more from us, we find that our road and bridge and drainage laws are inadequate, and in many instances obsolete. The Illinois Association of Township Officials passed resolutions at our last convention to have the following bills introduced at the next regular session of the Legislature: A bill to regulate weight of trucks, on gravel and oil roads, during soft weather; another relative to the moving of sheds, houses, and other buildings over our highways; and still another to change the tax levies, if possible. I believe the county superintendents could profit by helping us with these bills, and let us assure them, if they have any ideas for bills, that we will gladly coöperate with them in these matters, or in any other matters pertaining to our highways.

In conclusion, let me repeat once more, we are public servants, spending the same taxpayers' money, and whether it is state, county, or township, let us coöperate to one end—more and better roads in Illinois.

VI. PLANNING THE SECONDARY ROAD SYSTEM

F. N. Barker*

I believe all of you know that the Illinois Division of Highways since late in 1935 has been coöperating with the Bureau of Public Roads and its successor, the Public Roads Administration, in the conduct of a number of related studies designed to provide all of the data necessary for the planning of future road improvement programs. These studies, initiated as the State-wide Highway Planning Survey, were transferred early in 1939 to the Bureau of Highway Research of the Division of Highways. Many of the studies are highly technical, such as the study of highway capacities and truck performances. Others do not indicate conclusions immediately, but must be continued to determine trends. In the last ten years many methods of financing road improvements have been used and others discarded. Special assessments have decreased in the municipalities and are seldom used today. The traditional reliance of the counties and cities on the property tax has shifted to a greater dependence on state and federal grants of motor fuel tax, P.W.A., and W.P.A. funds. As an indication of the newest trend in federal aids, we have the secondary road program, the planning of which is the subject of this discussion.

The subject "Planning the Secondary Road System," as assigned by the Program Committee of the Twenty-seventh Annual Conference on Highway Engineering, is understood to mean much more than the mere selection of roads to be improved to supplement our existing primary system.

Many of the questions which must be answered in connection with the selection of a secondary road system have been answered in the past by estimates, or, as engineers call them, educated guesses, some good, some fair, and a few, unfortunately, bad. The planning survey, in assembling factual data on many phases of highway administrative problems, has tried, as far as possible, to find the answers in concrete facts. What traffic uses which roads? what use will be made of these roads after improvement? and finally, how shall we raise the necessary money.

Before considering the immediate problem of the selection of a secondary road system for Illinois, let us examine the existing highways of the state, the service performed by the several systems, and

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the expenditures on these systems. This examination must be brief and can best be made by use of a few charts and pictures.

This diagram shows the mileage of rural highways of each surface type on the primary, state-aid and local road systems. Practically all of the 9650 miles of the rural primary roads are paved. Of a total of approximately 17 600 miles of rural state-aid roads which are not coincident with primary routes, 1700 miles are paved, 11 800 miles are low type surface, and 4100 miles still have an earth surface. On the local or township system, only 132 miles are paved, 37 000 miles are improved with a low type surface and 38 500 miles do not have an all-weather surface. In the three rural systems, approximately 42 600 miles of road are still unsurfaced.

Roads are improved, or at least they should be improved, with the objective of service to traffic. Improved roads are unnecessary if there is no traffic. However, if the traffic warrants improvement of any particular road, the type of improvement should be dependent upon the amount and character of that traffic. While the volume and individual weights of commercial vehicles have a very important bearing on the type of surface necessary to carry this class of traffic, we will discuss only the total traffic volumes on the several systems.

In our original surveys most of our traffic counts were made manually. In the future, however, we expect to make most of our counts mechanically except for control counts, which, if a determination of the amount of commercial traffic of different weights is to be made, must still depend upon manual counts. As a digression from the immediate problem, I wish to show you a few pictures of the latest types of automatic traffic recording devices which we are using. Many of you have seen these machines installed at various locations, and some of you may have wondered what they were and how they worked.

This is a commercial automatic traffic recorder which is designed for continuous operation in permanent locations. The machine operates on the photo-electric cell or electric-eye principle and requires that a source of power of 110 volts a-c be available at the recorder. Two rays of light are projected across the road after being filtered so that the rays are invisible even in darkness. A simultaneous interruption of both rays is necessary for a recording, which eliminates pedestrians from the count. Traffic totals are stamped on a ribbon at hourly intervals and the only attention required by the machine is that of periodic inspection and removal of the records.

This is an experimental type of portable recorder which is giving

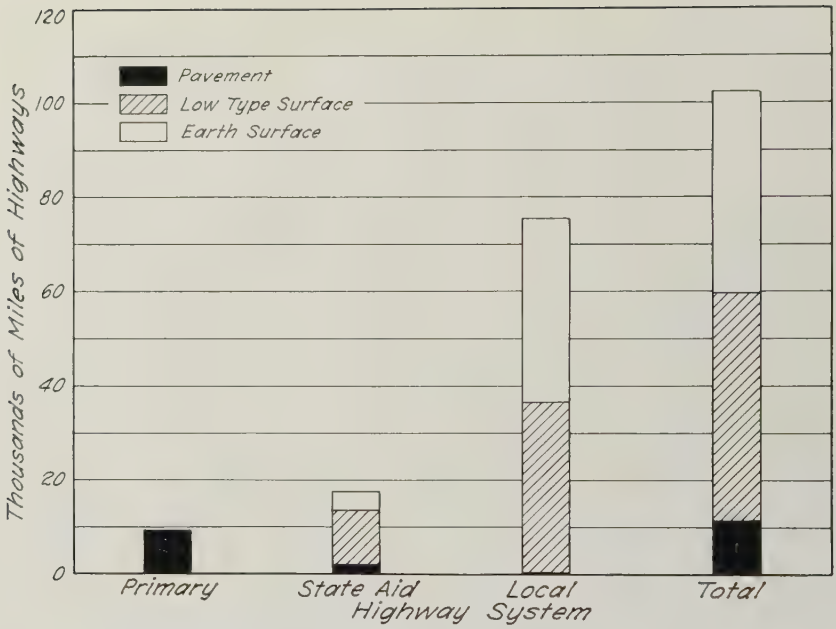

FIG. 1. MILEAGE OF HIGHWAYS OF EACH SURFACE TYPE IN EACH HIGHWAY SYSTEM

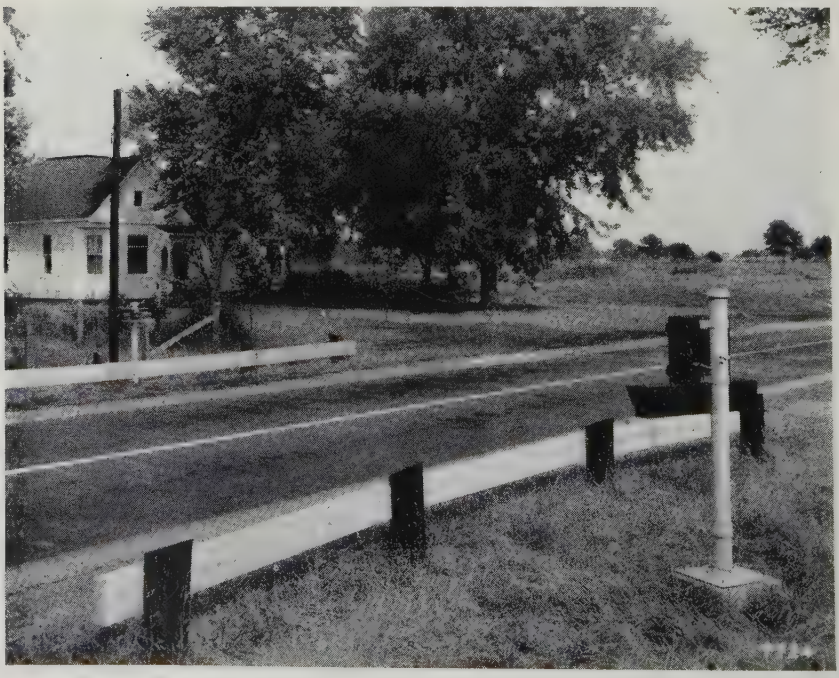

FIG. 2. COMMERCIAL AUTOMATIC TRAFFIC RECORDER

FIG. 3. EXPERIMENTAL PORTABLE TYPE AUTOMATIC TRAFFIC RECORDER

satisfactory service. The lower part of the steel housing contains a 6-volt storage battery. The rubber tube which is attached to the left end of this housing is stretched across the road. Vehicles crossing this tube cause an air surge which actuates a diaphragm to make an electrical contact. Two impulses are required to advance the counting mechanism one unit and totals are recorded at hourly intervals as in the case of the first recorder. A spring-driven eight-day clock regulates the stamping so that this machine requires attention once a week. The entire machine weighs 85 pounds, including the battery, requires no outside source of power, and may be installed in a very few minutes. A steel chain is used to lock the equipment around a tree, telephone pole, or other fixed object.

This is a third type of automatic recorder which also requires a rubber tube stretched across the road to provide an air surge against a diaphragm at the base of the machine. An ordinary cheap watch is connected to the diaphragm mechanically so that two movements of the diaphragm, representing two impulses from the tube caused by the two axles of a vehicle passing over it, cause the escapement to

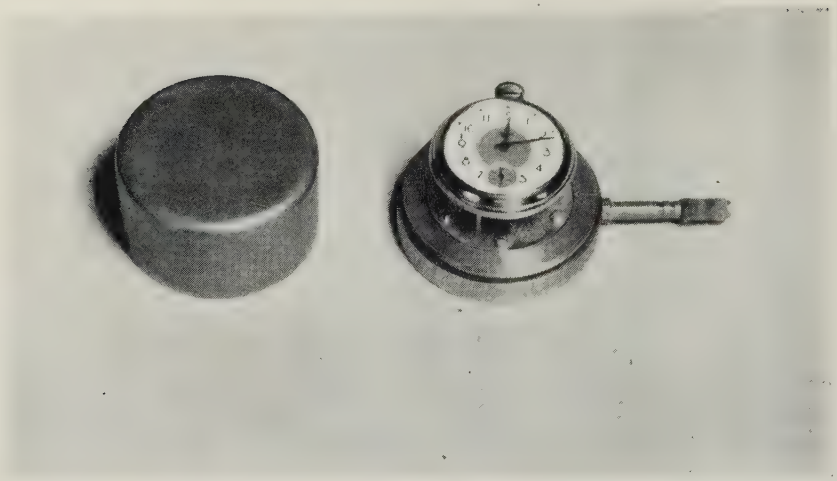

Fig. 4. Watch Type of Automatic Traffic Recorder

move two divisions. This records as one second on the watch face. This machine does not stamp traffic totals automatically, but must be read at stated intervals.

What is the relative traffic use of our primary, state-aid, and local road systems? It is to be expected that the rural primary system would show a higher average traffic density. This chart shows the mileage of highways of the rural primary system which carry traffic volumes as indicated on the horizontal axis. Only about 125 miles of this system carry less than 200 vehicles a day, while the volume groups between 300 and 3000 vehicles per day cover most of the system. The average 24-hour volume on all rural primary roads is 1150 vehicles.

This diagram gives the same information for rural highways in the state-aid system. Approximately 1500 miles of such roads carry an average 24-hour traffic of 10 to 24 vehicles, while a comparatively insignificant percentage of the total mileage carries traffic amounting to more than 500 vehicles daily. The average traffic on this system is 120 vehicles a day.

The two preceding diagrams show very clearly that our primary system does include most of the roads carrying medium to heavy traffic, and that the state-aid system in general includes roads of lower traffic volumes.

The average daily traffic on the local system is 29 vehicles, 44 000 miles carry less than 25 vehicles, 15 000 less than 10 vehicles, while

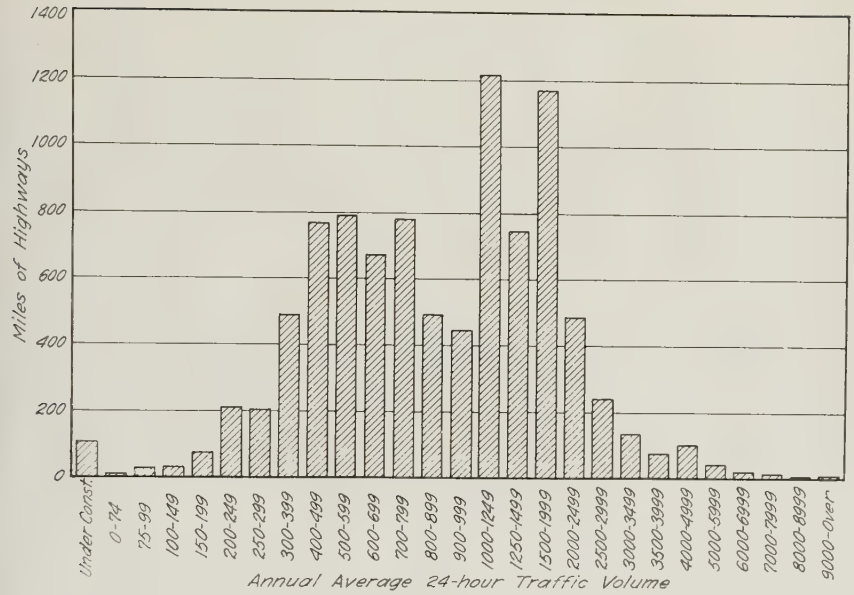

FIG. 5. RURAL MILEAGE OF PRIMARY HIGHWAYS IN ILLINOIS CARRYING VARIOUS VOLUMES OF TRAFFIC

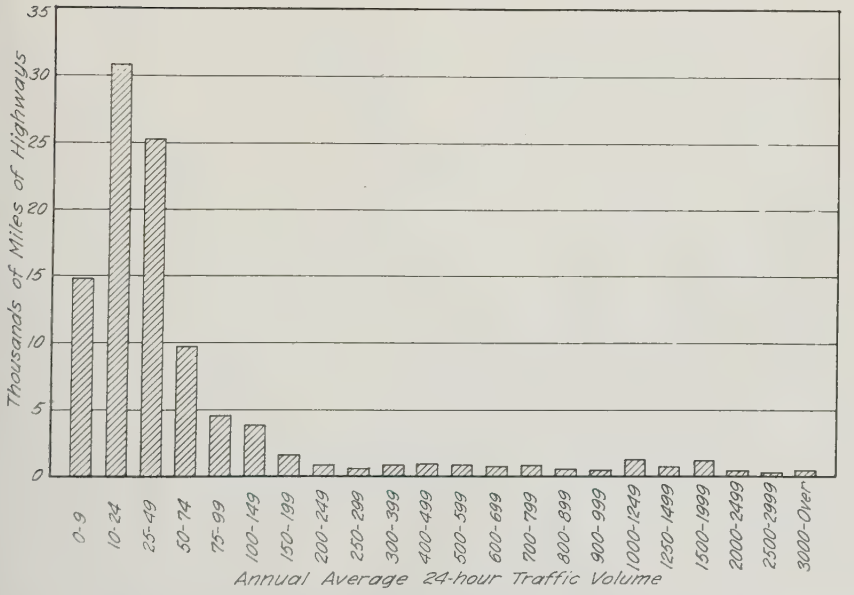

FIG. 6. RURAL MILEAGE OF STATE AID HIGHWAYS IN ILLINOIS CARRYING VARIOUS VOLUMES OF TRAFFIC

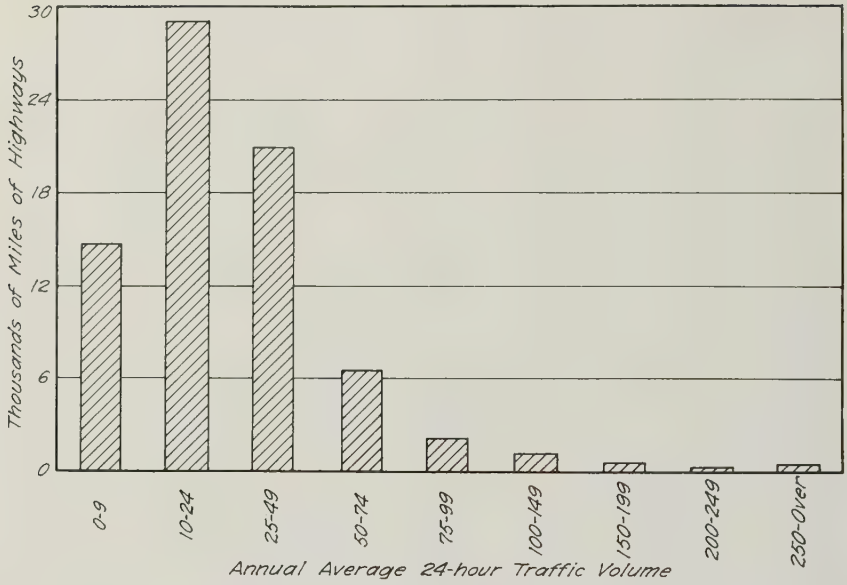

FIG. 7. RURAL MILEAGE OF LOCAL HIGHWAYS IN ILLINOIS CARRYING VARIOUS VOLUMES OF TRAFFIC

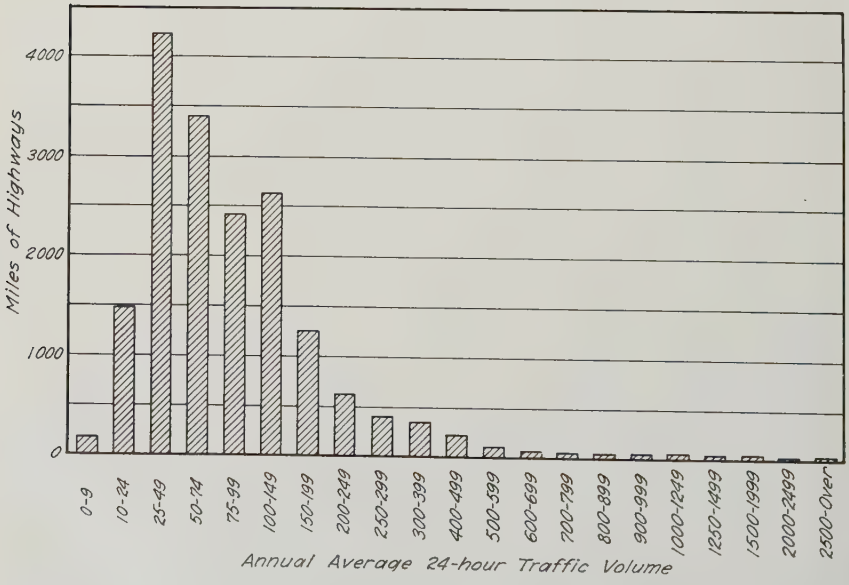

FIG. 8. MILEAGE OF ALL RURAL HIGHWAYS IN ILLINOIS CARRYING VARIOUS VOLUMES OF TRAFFIC

nearly 6000 miles carry less than 5 vehicles a day. Only two per cent of the entire system carries more than 100 vehicles a day.

The three preceding diagrams, because of the great difference in lengths of the systems, were placed on charts having different mileage scales. Let us now place them on a common scale. This is a combined chart showing the mileage of all rural roads carrying average daily traffic volumes as indicated on the horizontal scale. On this chart the large mileage of local roads in the low traffic volume groups appears in its true relation to the mileage of primary and state-aid roads in the higher volume groups.

It is a popular theory that all of our rural roads should be improved to at least an all-weather surface. May I advance the theory that, on the contrary, it is possible that many of these roads should be retired from the public system inasmuch as they serve only a few individuals, or at least should be supported by local land taxes? This is a township road carrying an average traffic of 5 to 9 vehicles a day.

This is also a township road carrying 5 to 9 vehicles a day. Below these in importance are roads which are used very infrequently and on which the average daily traffic is less than 5 vehicles.

When traffic on the three rural systems is converted to a vehicle-mile basis, this is the result. The primary system, including only 9.4 per cent of the total rural road mileage, carries 70.1 per cent of the total traffic. The state-aid system, including 17.1 per cent of the total rural mileage, carries 14.8 per cent of the total traffic, while the local system, although including 73.5 per cent of the total rural road mileage, accommodates only 15.1 per cent of the total rural travel.

In the preceding discussion only our rural roads have been mentioned. It is impossible to exclude city streets from consideration, and their place in the highway picture is shown by this diagram. It will be noted that the primary and state-aid systems here include urban extensions. On this basis the primary system carries 44.8 per cent; the state-aid system, 7.2 per cent; the local roads, 5.8; and local city streets, 42.2 per cent of the total annual travel.

This figure shows that a substantial part of the travel on each of the road systems in Illinois is contributed by drivers living in urban areas. Combination of the travel on the four systems of highways shows that about 86 per cent of the total travel in Illinois performed by resident of the state is contributed by vehicles owned in the cities.

This diagram compares the mileages in the various systems, the

Fig. 9. Township Road Carrying an Average Traffic of 5 to 9 Vehicles a Day

Fig. 10. Another Township Road Carrying an Average Traffic of 5 to 9 Vehicles a Day

traffic served by this mileage, and the expenditures of public funds now directed to the several systems. The primary system, comprising 9.3 per cent of the total mileage in the state, carries 44.8 per cent of the total traffic with an expenditure of 25.6 per cent of the total expenditures, from all sources, for highway purposes. The state-aid system, comprising 15.6 per cent of the total mileage, carries 7.2 per cent of the total traffic with an expenditure of 20.7 per cent of the total. Local roads comprise 61.6 per cent of the total rural mileage and carry 5.8 per cent of the traffic with an expenditure of 12.9 per cent of the total of expenditures for road and street purposes. Local municipal streets represent 13.5 per cent of the total mileage, carry 42.2 per cent of the total state traffic, and require an expenditure of 40.8 per cent of the total. I am sorry that time does not permit a detailed discussion of this chart as it is very interesting.

The preceding discussion indicates that the primary roads are the backbone of our public transportation system. As such, they are entitled to our first consideration. As you know, our primary roads consist principally of the state bond issue and federal-aid roads. Twenty years ago many of the most important roads in the state had been surfaced under the Bond Issue Law. What is the condition of these roads today? Unfortunately many of them are badly in need of replacement or modernization.

Twenty years ago it was generally thought that our concrete pavements would serve traffic perpetually and few people ever expected the "durable hard surfaced" roads to wear out. However, we find that many of them have worn out after years of faithful service. Even our pavements of the most modern design are expected to have service lives of not more than 30 years so that our pavements built 20 years or more ago, and which now need replacement, have given all the service which could reasonably be expected of them.

As a matter of interest, I have selected two photographs of pavements which were made on sections which we consider should be retired immediately. This is a pavement condition on Route 13 in Saline County, one and one-half miles east of Harrisburg. Traffic at this location averages 1500 vehicles per day.

This picture was taken on U.S. Route 66 in Madison County where the average daily traffic is 3300 vehicles.

What are we going to do about these veterans? This figure shows the costs which are expected to arise in connection with the maintenance and reconstruction of our primary system and the revenues from which we can expect to meet these costs. If a reasonable pro-

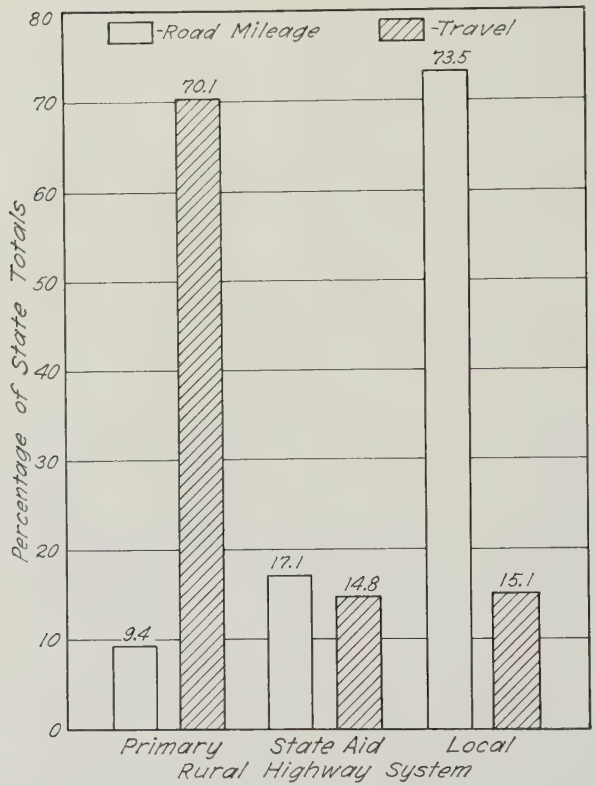

Fig. 11. Comparison of Rural Road Mileage with Vehicle Miles of Rural Travel on Each Highway System

gram of retirement and replacement is carried forward, together with other fixed costs which must be met, a considerable deficit will be incurred each year on the basis of anticipated revenues. By 1950 our deficit is estimated to be in the neighborhood of thirty-six million dollars, and in 1958 about sixty-five million. If we can this time build really "durable" roads, by 1963 we should be out of the red.

In this discussion I have intended to convey to you the idea that the planning of a secondary system for Illinois requires the careful consideration of a great many things other than the simple selection of the particular roads which we wish to include in the system. The whole problem has not been solved, nor will it be immediately, but we do believe that we have most of the basic data with which to attack the problem.

Section 7 of the Federal Act, approved June 16, 1936, amending

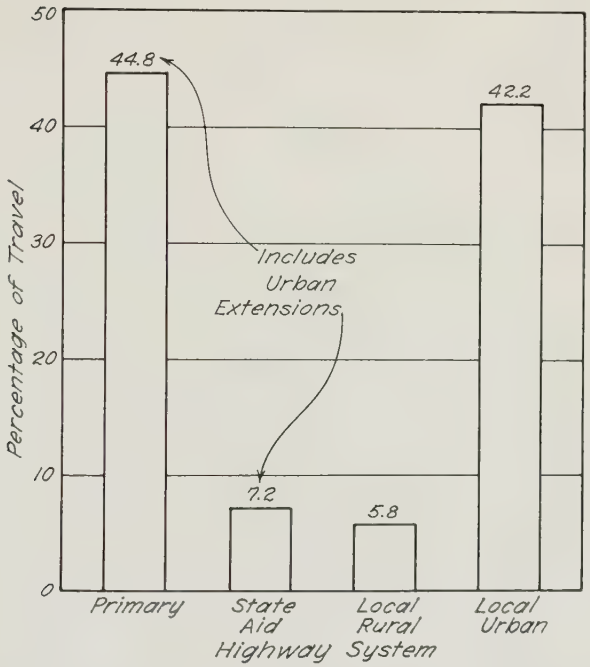

Fig. 12. Percentage of Travel Performed by Illinois Vehicles on the Various Highway Systems of Illinois

the Federal-aid Highway Act of 1916, authorized an appropriation for the fiscal years ending June 30, 1938, and June 30, 1939, for the construction of secondary or feeder roads, including farm-to-market roads, rural free delivery mail roads, and public school bus routes. Being merely an appropriation act, the Act of June 16, 1936, did not further define the roads which were to be improved with funds authorized by Section 7. Rules and regulations for carrying out the provisions of this section were approved by the Secretary of Agriculture on February 9, 1937, and these rules, together with subsequent interpretations made by the Bureau of Public Roads, now the Public Roads Administration, formed the principles on which our Illinois laws were amended to allow the state to receive federal aid for secondary road improvements and on which our selection of the roads to be included in the federal-aid secondary system will be based. The brief definition of secondary or feeder roads as referred to in the Act of June 16, 1936, was expanded in the rules as follows:

"Secondary or feeder roads" shall mean roads outside of municipali-

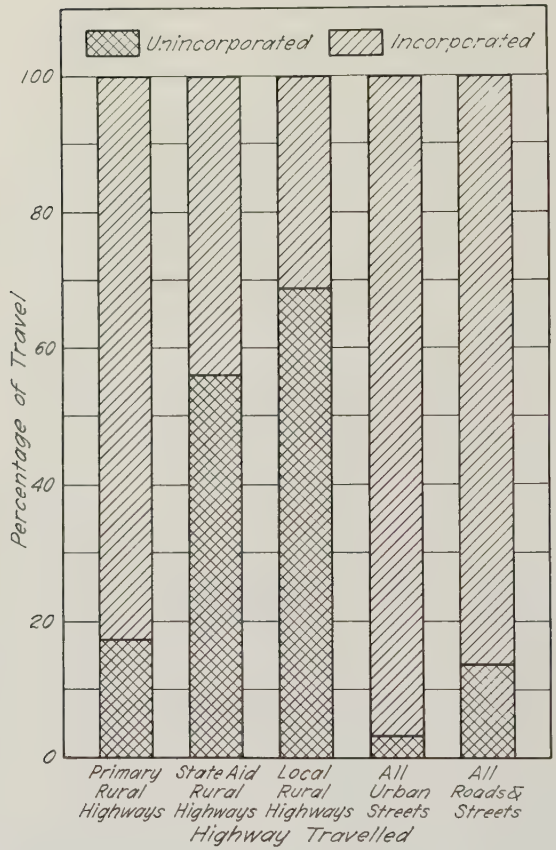

Fig. 13. Percentage of Travel Contributed on Each Highway System by Illinois Owners Resident in Rural and Urban Areas

ties, except as hereafter provided, which are not included in the federal-aid highway system, and shall include farm-to-market roads, mine-to-market roads, rural free delivery mail roads, public school bus routes, and other rural roads of community value which connect with important highways or which extend reasonable adequate highway service from such highways, or which lead to rail or water shipping points or local settlements. The limitation with respect to roads within municipalities shall not be construed to prevent improvements into or through small municipalities when such improvements are necessary for continuity of service.

The same document required that projects undertaken under the Act be designated as "Federal-aid Secondary" projects and from this

the system of secondary or feeder roads received its official title of the Federal-aid Secondary System.

The rules and regulations approved February 9, 1937, further require that the State Highway Department undertake the selection and designation of an initial system or group of secondary or feeder roads for construction or reconstruction, based upon their relative importance as determined from factual data secured from state-wide studies for the planning of a complete highway system, and submit a suitable description and map of such system to the Public Roads Administration for approval. The mileage of the initial system shall not exceed 10 per cent of the highway mileage of the state, as shown by the records of the State Highway Department at the time of the passage of the Federal Highways Act.

The rules and regulations require further that project agreements for federal-aid secondary road improvements shall provide for the maintenance of such projects by the state to the extent permitted by state laws, otherwise the state shall submit an agreement for such maintenance with the county or other political subdivision which had been responsible for the maintenance of the road prior to its designation as a federal-aid secondary route.

Our state law concerning the selection of the federal-aid secondary system, its construction, and subsequent maintenance reads as follows:

"The Department of Public Works and Buildings, subject to the approval of the Federal Government, is authorized to designate a system of secondary roads consisting of not more than 10 000 miles, said roads to be designated as rapidly as funds are made available by the Federal Government for their improvement. All such secondary roads shall be known as Federal secondary roads.

"The roads comprising said system shall be exclusive of State Bond Issue roads and Federal Aid roads and shall consist of the following: farm-to-market roads, mine-to-market roads, rural free delivery mail roads, public school bus routes and other rural roads of community value which connect with important roads, or which lead to rail or water shipping points or local settlements; also roads through municipalities when such roads are necessary for continuity of service.

"Any road designated as a part of the Secondary road system may be improved, constructed, or reconstructed jointly at the expense of the Federal Government and the State of Illinois, or the Federal Government alone.

"The county, township or municipality having jurisdiction over any street or road prior to its selection and improvement as a Federal

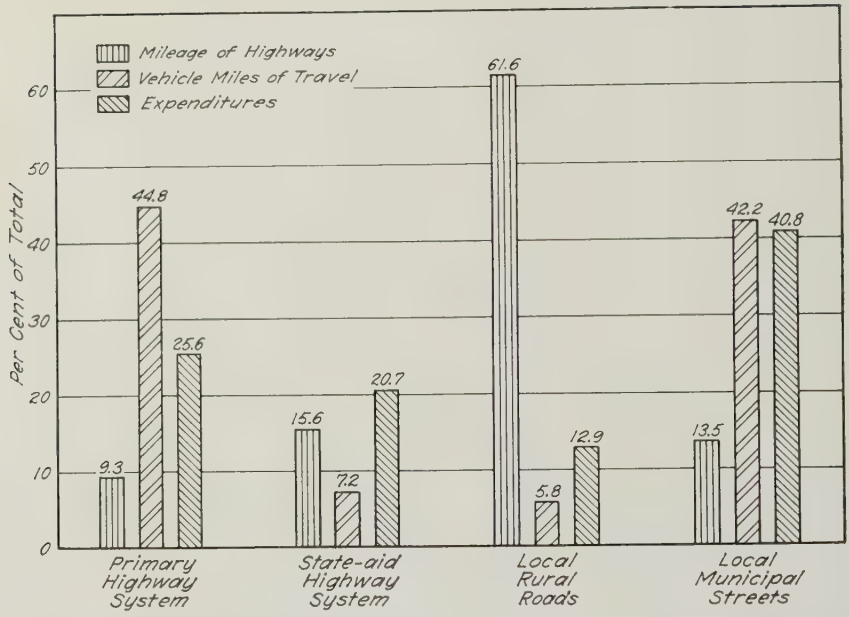

FIG. 14. PERCENTAGE DISTRIBUTION OF HIGHWAY AND STREET MILEAGE, TRAVEL, AND EXPENDITURES FOR HIGHWAY PURPOSES, ACCORDING TO HIGHWAY SYSTEM

secondary road shall continue to be responsible for the maintenance thereof, which maintenance shall be in accordance with the specifications adopted by the Department of Public Works and Buildings. The Department of Public Works and Buildings is also authorized to maintain any such street or road after it has been improved, constructed, or reconstructed as a Federal secondary road, and, subject to the approval of the Federal Government is authorized to enter into an agreement with the county, township or municipality responsible for the maintenance for such street or road whereby the cost of the maintenance of all or any part of such street or road shall be borne by such county, township or municipality. In case any county, township or municipality shall fail to maintain, in accordance with the specifications adopted by the Department of Public Works and Buildings, any street or road improved, constructed or reconstructed as a Federal secondary road, or shall fail to pay the cost of such maintenance in accordance with its agreement with the Department of Public Works and Buildings, no new project shall be approved for the improvement, construction or reconstruction of any street or road under the jurisdic-

tion of such county, township or municipality until the requirements of this section or of any such agreement have been fulfilled."

Your attention is directed to one point concerning which the federal rules and regulations and the state laws are not in agreement. The federal law and regulations exclude from the system only roads already included in the regular federal-aid system or which are potential additions to this system, National Forest highways, roads in military reservations, and roads and streets within the corporate limits of municipalities, except where an improvement of a city street is necessary to provide continuity of service. In addition to these, the state law definitely excludes state bond issue roads that are not on the regular federal-aid system. Except for this difference, the federal laws and regulations and our state laws are in practical agreement, but this difference is of primary importance. It means, in effect, that if the federal regulations are followed, the system will include the roads next in importance to the regular federal-aid system, and that 2320 miles of our state bond issue roads not in the regular federal-aid system must be included in the federal-aid secondary system. The average traffic carried by these roads is 735 vehicles per day, and many of them carry traffic volumes greatly in excess of that which would indicate secondary service.

The most important principles recommended by the Administration to be followed in the selection of roads for the federal-aid secondary system, and, in the relative order of their improvement, are:

(1) In the selection of roads consideration shall be given to the possibilities of creating economic and social values in the areas served by the proposed improvements. Related to this principle are the location of submarginal agricultural land in the areas to be served by a particular road which would indicate that this land might be retired and even depopulated, or the location of federal resettlement projects or any other predictable developments which would be likely to increase the density of land settlement.

(2) Subject to the foregoing considerations, preference should be given to roads that connect farms and rural homes with railway and water loading points, schools, churches, and other points of public congregation including community developments and unincorporated places.

(3) In the absence of compelling reasons to the contrary, sections of secondary or feeder roads proposed for improvement shall connect with the previously improved highway system, and preference shall be

FIG. 15. PAVEMENT CONDITION ON ROUTE 13 IN SALINE COUNTY

given to projects that connect with the improved system at two ends.

(4) A definite need for the improvement of each project must be demonstrated. This need might be indicated by impediment or hazard to travel in any season or by excessive maintenance costs of the road in its present state. From this consideration any road which is eligible for inclusion in the system would be qualified for improvement if it did not have an all-weather surface; if the location and design were inadequate to serve existing or potential traffic; or if the maintenance cost of the present road was considerably above the general level of maintenance costs for roads of its particular type.

(5) Selection between roads considered to be in need of improvement shall be made upon consideration of the relative importance and amount of their potential traffic. The character of the traffic is to be considered as well as its density, and the aim shall be to promote the improvement of those roads that, to the greatest extent, facilitate transportation of farm products to markets, and extend to rural areas the benefits of urban development. It is understood that if the present traffic is used in the selection of roads for the system, proposals for

FIG. 16. PAVEMENT CONDITION ON U. S. ROUTE 66 IN MADISON COUNTY

the improvement of particular projects shall be accompanied by an estimate of the present average daily traffic based on actual traffic counts. If potential traffic estimates are used they shall be based on origin and destination studies or on sound estimates of natural traffic increases due to predictable developments or natural increases in traffic.

(6) No project shall be approved unless the work proposed to be done will result in a substantial improvement of the roadway. This means that improvements bordering on maintenance will not be approved as construction projects.

The general procedure to be used in the selection of roads for the secondary system has been established by the Administration. This routine is based on data collected by the State-wide Highway Planning Survey. It is required that the total system mileage in each state be distributed among the several counties on the basis of factors indicative of the comparative agricultural importance of the counties. The federal regulations emphasize that the system is to serve principally the farmer and the rural communities.

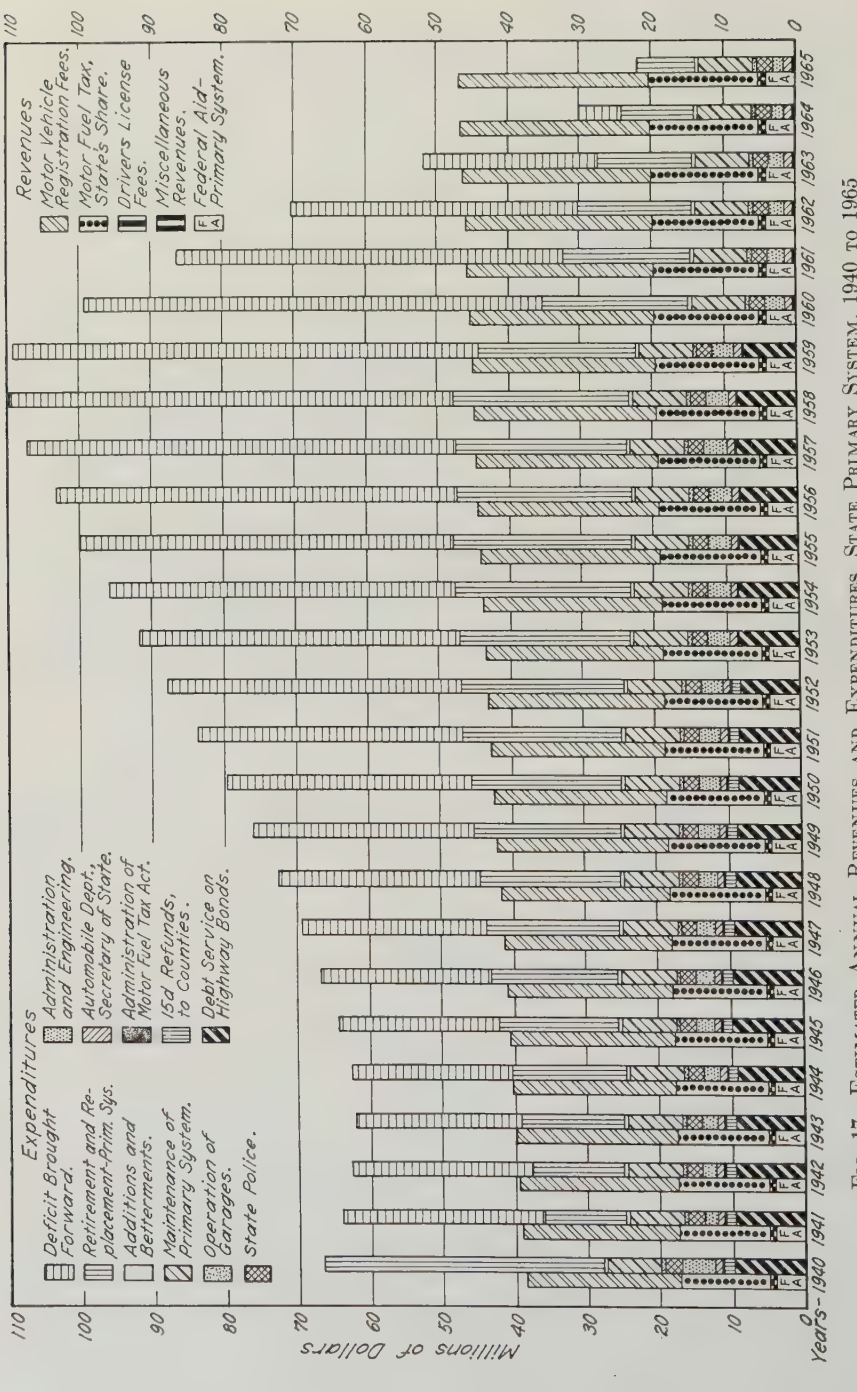
Millions of Dollars
Years
Expenditures
Deficit Brought Forward.
Retirement and Replacement-Prim. Sys.
Additions and Betterments.
Maintenance of Primary System.
Operation of Garages.
State Police.
Administration and Engineering.
Automobile Dept., Secretary of State.
Administration of Motor Fuel Tax Act.
15d Refunds, to Counties.
Debt Service on Highway Bonds.
Revenues
Motor Vehicle Registration Fees.
Motor Fuel Tax, State's Share.
Drivers License Fees.
Miscellaneous Revenues.
Federal Aid-Primary System.
F A
1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965

FIG. 17. ESTIMATED ANNUAL REVENUES AND EXPENDITURES, STATE PRIMARY SYSTEM, 1940 TO 1965
(State of Illinois Highway Planning Survey)

The factor approved by the Administration for use in Illinois is based on the characteristics of (1) "Farm Population," (2) "Value of Farm Products Sold or Traded," and (3) "Vehicle Miles of Travel by Rural Residents on Roads Eligible for the Federal-aid Secondary System." Each of these characteristics is to be given equal weight.

Champaign County will be used to illustrate the exact derivation and application of the county factors. The farm population of Champaign County, as determined by the Bureau of the Census, amounts to 1.62 per cent of the total farm population of the state. For this county, the value of farm products sold or traded amounts to 2.67 per cent of the state total, while the vehicle miles of travel by rural residents on eligible roads in the county amounts to 2.03 per cent of the total vehicle miles of travel in the state by rural residents on all eligible roads. These factors average 2.19 per cent of the state total.

Because of the conflict between the state law, which prohibits inclusion of non-federal-aid bond issue routes in the federal-aid secondary system, and the federal policy which requires that roads next in importance to the regular federal-aid system be included, it is necessary that some compromise be made to satisfy both requirements. Accordingly, it has been agreed that the state will reserve from the total mileage of the federal-aid secondary system a sufficient mileage to absorb the non-federal-aid state bond issue roads when, and if, the state law is amended to allow these roads to be included in the secondary system. This results in a mileage of 7680 to be distributed among the 102 counties of the state rather than the 10 000 miles authorized by law. Application of the factor of 2.19 per cent, which is the average of the three basic economic factors, results in a total system mileage for Champaign County of 168 miles. This then is the mileage available to Champaign County under existing requirements. If it develops that the non-federal-aid state bond issue roads do not have to be placed in the system, then the county would receive an additional 51 miles of federal-aid secondary roads.

Having determined the total county mileage, the selection of particular roads to be included in the system must, according to federal requirements, be based entirely on their present or estimated future traffic use. A graphical method has been developed by means of which the selection of county systems is greatly simplified. Cumulative mileage of eligible roads and cumulative vehicle miles of travel on these roads are plotted against traffic volumes. Inspection of this chart for Champaign County indicates that the 168 miles of eligible roads carrying the greatest traffic volume include all such roads in the county

having an average 24-hour traffic volume of 100 vehicles or more. The county traffic map has been used as a base for road selection. First, all ineligible roads are indicated on the map, distinction being made between regular federal-aid roads, potential extensions to these roads, and state bond issue roads not in the regular federal-aid system. Next, all roads carrying 100 vehicles or more which have not been noted as ineligible are located on the map. This group of roads is then considered. Usually it is found that some of the roads of the first group do not fit in a reasonable manner in a secondary system. For instance, two parallel roads a mile apart may be included in the first group. In such a case one of the competitor roads should be selected and the other rejected. In Champaign County it happens that 126.5 miles were selected from the first group and 50 miles rejected for various reasons. Reference was then made to the traffic chart from which it was determined that the 50 miles carrying the next highest traffic included those roads carrying 75 to 99 vehicles. From this second group 13.9 miles were accepted. The third group was then located on roads carrying less than 75 vehicles a day and the remainder of the 168.0 miles was selected from this third group.

Many difficulties remain to be adjusted before a final decision can be reached concerning the roads ultimately to be designated in the secondary system. The Public Roads Administration and the state are not yet even in complete agreement on the mechanics of selection. After this selection is made the matter of priority of improvement and responsibility for maintenance remains to be decided. It is hoped that the federal allotments for federal-aid secondary construction will be increased in the future. This cannot be guaranteed, and it is even possible that they will be reduced. At any rate the financing of the construction and maintenance of our federal-aid secondary roads is a problem which must be considered in the planning of our future road programs.

VII. SYMPOSIUM ON STANDARDS FOR SECONDARY ROADS

(1)

H. E. Surman*

In opening this symposium on Standards for Secondary Roads, it might be well to have first a brief discussion on the definition of a secondary road. In the past the definition has varied, depending upon the political unit to which the question was put. If a township official were asked the definition of a secondary road, he would probably say: "All roads in the township not on the federal aid or bond issue system." If a county superintendent of highways were asked that question, he would probably say: "The state aid system of highways." The state would probably define the term as those roads carrying the greatest amount of traffic next below the federal aid and state bond issue systems. The Federal Government defines the term as those roads carrying the greatest amount of traffic next below the federal aid system. Mr. Webster defines the word "secondary" as "next below the first in importance." So here you have a wide variety of definitions for the term "secondary roads." For the purpose of this discussion, we will assume the term to apply to those roads next in importance to the federal aid and state bond issue systems which will require some type of all-weather surface, but, before proceeding with the subject of standards for such roads, it is necessary to clarify another point in regard to the usage of the expression "Secondary Roads." The selection of such a system on a state-wide basis would vary considerably, depending upon the political unit selected in choosing those roads which are next in importance to the federal aid and state bond issue systems. If, for example, the state were chosen as the unit in selecting such a system, quite a few of the poorer counties would receive very little mileage in such a system, and in some cases none whatsoever. For example, a secondary road having the least amount of traffic selected in Winnebago, LaSalle, Rock Island, Sangamon, Peoria, St. Clair, and other more populous counties, would probably have more traffic than the secondary roads having the greatest amount of traffic in Hardin, Pope, Gallatin, and other sparsely settled counties. This would obviously be an unfair method of selecting the secondary

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system. Therefore, it is important that each county be taken as a unit in selecting the secondary road system on a state-wide basis.

The design policies for rural highways outlined by the State Division of Highways specify six different classifications. These are based on traffic densities. Classes A, B, and C are applicable mainly to the Federal Aid and State Bond Issue Systems, or, in other words, the primary system of highways. Classes D, E, and F represent the secondary and tertiary highways. Most of the secondary roads will come under classes D and E, while some of the secondary roads in the sparsely settled counties will come under class F. Standards of policies are outlined quite in detail under these various classifications, and since these are in the hands of all the county superintendents of highways, it is not necessary to repeat these details in this paper.

According to traffic information obtained by the Bureau of Highway Research of the Illinois Division of Highways, approximately three hundred (300) miles of the state aid system of seventeen thousand, six hundred and eleven (17 611) miles have an average daily traffic in excess of 800 vehicles. About 700 miles show average daily traffic of from 300 to 800 vehicles, and about 5000 miles carry average daily traffic of between 100 and 300 vehicles. There are probably one to two thousand miles additional rural roads not on the state aid, bond issue or federal aid systems carrying average daily traffic in excess of 100 vehicles, making a total of 7000 to 8000 miles of such rural highways carrying more than 100 vehicles per day. All such roads should have an all-weather surface, and most of them should be provided with a dustless surface. Those secondary roads carrying average daily traffic of less than 100 vehicles should have some type of all-weather surface, but not necessarily a dustless one. Whether or not a road is of sufficient importance to justify an all-weather surface should be determined by the estimated amount of traffic it will carry after improvement. However, the fact should be recognized that in a few sections of the state only a small percentage of secondary roads when selected on the above-mentioned basis will carry enough traffic to warrant surfacing, and it would be impossible to establish a well-rounded secondary system in such localities based purely on economic justification. We cannot fairly deny our sparsely settled areas all right to all-weather roads, but must give some weight to the social welfare of improved transportation facilities.

When it comes to designing a secondary road, there are a few things to be considered that have not been given much thought in the past. The most important of these is the design of the subgrade.

Every section of road, whether it is to be paved with a rigid-type surface or simply to receive an oil treatment, first of all should be diagnosed for possible defects in the existing subgrade. In other words, a soil survey should first be made. This should be followed by a simple application of corrective treatments such as might be necessary to produce a proper foundation on which to place the highway surface. In some cases this will call for removing of certain soils and replacing them with more stable types. In some cases some sort of soil stabilization will be the solution, and, in still others, additional sub-drainage will prove to be necessary. While the writer had no special dislike for chemistry in his high-school and college curricula, still it has seemed to him that our soils experts speak too much in the terms of chemistry in attacking the soil problem. We know quite definitely the different types of soils encountered in our Illinois conditions. Experience has taught us that certain soils are unstable and must be removed and replaced with a satisfactory material. We also know quite definitely what types of soils can be drained satisfactorily. There are certain intermediate types of soils which make a satisfactory subgrade during most of the year when they are not too wet, but which are unsatisfactory during the early spring months just after the frost has left the ground. This latter class is the most difficult to treat satisfactorily. What is needed in our soils work is the use of a simpler language so that we can all understand the soil problems more fully. Certainly, soil studies and their corrective treatments are just as important with a semi-rigid type of wearing surface as in the case of a rigid pavement. The importance of the problem is accentuated by recent experiences in connection with rigid pavements due to the increase in the amount of truck traffic. Some pavements which have served years without showing any distress have suddenly shown definite signs of failure due to the increased number of truck movements, which has resulted in the pumping action of mud and water at joints and cracks. This has left certain areas under the pavement without support, this condition being followed by corner breaks and general disintegration. Therefore, in the design of semi-rigid types of wearing surface where considerable truck traffic is expected, it is important that adequate bases be provided in addition to proper subgrade treatment. Such bases on the more heavily traveled secondary roads should be not less than 8 inches in thickness.

Another important design feature is to keep the road surface above the surrounding terrain wherever possible, and the use of flat slopes, especially on the more heavily traveled roads; the use of level grades

should be avoided wherever feasible. Attention to these particulars will go a long way toward avoiding heavier maintenance expense after the road is placed in operation. This will result in better drainage and will help to avoid the drifting of snow during winter months. Experiments made by the State of Michigan, the results of which were published in Bulletin No. 86 by the Michigan Agricultural College, East Lansing, Michigan, indicate that the grade line should be kept above the surrounding terrain by an amount equal to the depth of snow fall for the winter. Also, that in cuts, flat slopes will tend to avoid snow drifts, and that this, coupled with wide ditches through cuts to permit snow storage, will help materially toward solving the snow drift problem. All of this will require that the road be placed on a right of way of ample width to permit the construction of flat slopes and extra wide ditches in cuts. It is not the intention to infer that all secondary roads, regardless of traffic, should be so designed, but certainly we are justified in giving such considerations to the more heavily traveled secondary roads.

In the past, standards of design have been dictated more or less by the amount of money available for the project. This is an expensive policy, as it usually leads to considerably increased cost during maintenance operations. It would be a much better policy to reduce the length of the road and do a better job as far as the money will go than to lower the standards and stretch the length. As a rule, higher standards of construction are demanded when a higher unit of government performs the work. Counties are expected to do a better job than townships, the state a better job than the counties, and the Federal Government a better job than the state. While appropriations at the present time for federal aid secondary roads are much too small to satisfy the public appetite for such roads, still we must cut down on the length in order to do the best job possible, and it is only on the more lightly traveled secondary roads that compromises should be permitted with reference to standards of design.

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(2)

R. L. Schoenberger*

There are many classes of secondary roads and it is, therefore, necessary to have more than one standard or set of rules controlling their construction and maintenance. In the construction and mainte-

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nance of secondary roads there are so many factors to be taken into consideration that any set of rules prepared to govern the construction and maintenance of each of the many varieties should be construed in a flexible manner.

Secondary roads are generally classified according to the amount of traffic which they carry. They could also be classified according to the wealth of the unit of government which must finance them, or according to topographic conditions, or even to soil conditions. At the present time the Illinois Design Policies for Rural Highways take into direct consideration the amount of traffic and the topography of the country through which the road runs.

Some of the other factors involved, after the road under consideration has been classified according to traffic and topography only, are:

(1) Funds available
(2) Soil conditions
(3) Local road surfacing materials available
(4) Utility
(5) Durability
(6) Safety
(7) Local manufacturing or material plants
(8) Climate, etc.

If, at least, the most important of these are not considered unsatisfactory roads are likely to be built.

Roads are built and maintained to serve the people who use them. They are not built for the reason that a tax can be collected for their construction or maintenance, that it gives some of us jobs, or that it furnishes a market for steel and cement. That should be kept in mind in a discussion of standards for secondary roads, and the aim of the set of rules should point toward "good value for the funds expended."

Flexibility in the interpretation of rules should not be confused with inferior rules or workmanship. Standards should be of a high order, interpreted with reason and good judgment. If there is fair local road surfacing material in the vicinity of a road to be constructed it probably would be good judgment to use it. If the same material must be shipped or hauled twenty or thirty miles it might be poor judgment to use it.

Enough secondary roads have been built in all parts of Illinois to furnish examples from which highway engineers can draw conclusions. If a certain type of road has been constructed in a certain area

for many years and the type has given good service at a reasonable maintenance cost, and actually has given the people good value for the funds expended, that type should be adhered to until it is proven that another type will represent better value for the funds expended. There should be no change merely for the sake of change.

If a certain area has built a certain type of road for many years on a 60-foot right of way, and it has proven satisfactory to all concerned even with increased traffic, why raise the required right of way width to 80 feet?

If a certain area has built gravel roads on certain soils 4 inches thick and 20 feet wide for many years, and they have proven satisfactory from all angles, why increase the thickness to 6 inches, and the width to 24 feet?

Short stretches of experimental roads should be built now and then to try out new ideas, and if worthy these ideas should be incorporated in future work. However, some things in road building are self apparent and fundamental, and no experimental roads need be built before the standards are changed to meet changing conditions. In the last few years car speeds have increased so that it is necessary that sight distances, both horizontal and vertical, be increased, and that the safe speed on horizontal curves be increased. In fact, all safety factors should receive more thought and consideration as speeds increase even though the safety factor in secondary road work is of less relative importance than it is in primary or trunk-line road construction.

Some phases of road construction can be governed by exact rules. For examples the location of steel in concrete and the amount of cement to use with a certain amount of sand and gravel. Other phases of road work are not among the so-called exact sciences and many of them are matters of personal opinion. The rules therefore should take this into consideration. Perhaps wider right of ways are needed in the snow belt than are needed farther south. Perhaps in some areas, infested with farm tractors or much local hauling, an auxiliary tractor road is needed along concrete or black top roads.

There are so many varieties of secondary roads and so many local conditions affecting them that no one or two sets of rules can govern them. A secondary road may only serve one farm home, or it may connect two small cities located 20 miles apart and carry up to 400 vehicles per day, including many heavy trucks.

The least important roads have been or will be improved with oil or gravel. This will continue until every farm home in Illinois has

something better than an earth road. This cheapest type of improvement should be considered maintenance work rather than construction work. It should give the farmer what he wants; that is, a fair riding surface the entire year for his automobile. A one-way traffic road, including structures, is entirely satisfactory to him and that type should be used where the road only serves two or three farm homes.

The most important roads should be constructed with two ideas in mind. They should give good service, or, in other words, please the public, and their annual maintenance charges should be reasonable—say under $200.00 per mile per year. These more important secondary roads should be surfaced with concrete or black top, and they should be built to a high standard.

Most secondary roads are listed between the two described. These roads serve many farm homes, have mail routes, milk routes, school bus routes, etc., passing over them. The amount of traffic may be rather light but it is important—it must get through. This type should be improved with stone or gravel unless local experience, in the past, has proven some other type to be satisfactory to the public using them. These roads should provide for two-way traffic and should be built to a good standard in order to keep future maintenance costs low.

If a secondary road is to be constructed which, in time, will be incorporated in the trunk-line system of the state it presents a special problem. It should be either constructed to a high standard, or as cheaply as possible and as a temporary proposition, keeping in mind the immediate needs of the public for that road. The funds available to the unit of government constructing the road should determine if the road is to be built so that it can or cannot be incorporated into the trunk-line system at some future time.

Taken in the aggregate road work in Illinois, including the rules and regulations, has been of a high order and the people appreciate it. This is evidenced by the fact that in the present political campaigns little is being said about road work.

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(3)

Lewis E. Barenfanger*

The Design Policies for Rural Highways, first adopted by the Illinois Division of Highways in 1936 and later amended, was certainly a step in the right direction toward rational development of rural

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highways. If such a policy could have been set forth twenty years prior to this date the State Highway System would be relieved of many miles of obsolescent highways. Failure to adopt such a policy at an earlier date is easily understood because, as has been pointed out so many times, the automobile literally jumped the traces on the highway engineers. A speed limit of thirty miles per hour existed in 1920. Today there is no speed limit. However, even if the engineer of twenty years past definitely could have foretold the radical improvement to take place in the automobile, could he have adopted higher design standards? Could he have sold the modern conception of adequate right-of-way widths and easy horizontal alignment to a public accustomed to the speeds of old dobbin or even a Model T? It was the public, after all, that procured the rights of way for these early state highways.

The foregoing should warn us that the future highway needs will largely be unpredictable, and an adequate design of today is the antiquated design of tomorrow. In other words it is very seldom that a highway is over-designed from the standpoint of right-of-way widths and horizontal alignment.

These observations were drawn from looking at the primary highway system of the state, but to a certain degree the same conclusions will apply to secondary roads.

In the Illinois Division of Highways Design Policy for Rural Highways there is set forth minimum policies for secondary roads. Generally speaking from my experience as county superintendent of highways of Marion County I find these design policies operate satisfactorily. Our situation in Marion County, located in the section of the state where soil fertility is meagre if not negative, is undoubtedly different from that in the black dirt counties farther north where land values are high. I find it very little more difficult to secure an 80-foot right of way than a 60-foot right of way. Our policy when constructing county roads is to have the property owner donate the necessary rights of way. Obstreperous property owners are either mollified by emolument received from other parties interested in seeing the improvement made, or coerced by a threat from the County Board to spend the money on some other road, since we in Marion County are in the unenviable and universal situation of having many places to spend money for improvements.

It is always convenient, when being brow beaten by an irate property owner whose land one covets for a relocation, to explain that the design policy which necessitates this seemingly unwarranted

and wanton encroachment on private property originates in Springfield. This must be "cricket" because I've observed the district right-of-way engineer for the Illinois Division of Highways take advantage of the remoteness of the Bureau of Public Roads in explaining a similar situation. In other words having a disinterested remote authority set design policies alleviates considerable embarrassment for local officials. If the design policy was left entirely in local hands there would be none.

One weakness I see in standards adopted too blindly and trustingly is that local conditions will not be given sufficient weight. Standards adopted for a state the size of Illinois with its greatly varying climatic, sociological, industrial, agricultural, and economic conditions, naturally need a varying degree of latitude in the application of such standards. I think as a whole the Department has recognized these widely divergent conditions and generally interprets the execution of these standards quite reasonably.

There is one lamentable tendency in road construction and that is toward higher cost per mile. This can be attributed to a certain extent to raised labor and material costs. Some of the causes of these higher costs are due to design engineers' penchant for adopting new refinements which, no doubt, are of value, but nevertheless greatly increase the cost of the finished product. Apparently engineers, in their enthusiasm to improve existing materials, machines, techniques, and products, overlook the fact that many of these improvements are not worth the added cost.

It seems to me that before any standard is adopted which will increase the cost of road construction the responsible engineer should ask these questions, "Is it worth it? Will it save its cost in decreased maintenance? Will it save lives?"

In summary, standards for secondary roads are vital for a well-planned highway system. Any adopted set of standards needs close scrutiny in applying them to local conditions. Designs which raise construction costs should be viewed with suspicion.

(4)

S. E. Farin*

There appear to be several schools of thought with respect to federal participation in rural roads off the federal aid system; first, that the use of F.A.S. funds should be confined to the construction of

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roads second only to the primary system; second, that the use of federal funds should extend to roads far removed from the primary system, in other words, those of the tertiary system, or those locally known as township roads; and third, that no government funds should be used on roads not on the primary system. It seems, however, that present laws and regulations relating to secondary roads provide principally for the application of F.A.S. funds to the first of these, that is, the construction of roads second only to the federal aid system, and with this in mind I wish to discuss standards for these secondary roads, first, with respect to design.

It apparently is not the policy of the P.R.A. to establish specifications and require adherence thereto, but rather to act upon plans and specifications submitted to it for approval and, in addition, from time to time from experience and for the sake of uniformity, to formulate essential policies by memorandum or letter.

During the past few years the Illinois Division of Highways through its Bureau of Design has formulated a tangible plan of design under the title of "Design Policies for Rural Highways" which gives the design characteristics for six classes of roads designated by letter from "A" to "F" inclusive. Generally speaking, the first five classifications in their application to plans have been favorably received by the P.R.A. However, Class F does not, in several respects, meet established minima.

Time will not permit a discussion of all of the items of design but let us, for example, consider one requirement. P.R.A. General Memorandum No. 66 establishes 24 feet as the minimum width generally acceptable for bridges new or to be reconstructed and, in addition, restricts the use of F.A.S. funds when adjacent existing structures have narrow roadway widths (16 or 18 feet, depending upon the traffic), requiring the reconstruction of these structures with or without the use of federal funds before approving participation in the adjacent improvements.

Figures included in the Illinois Bureau of Highway Research Preliminary Tabulation of Road Inventory Data indicate that there are over 23 000 bridges, representing over 1 300 000 lineal feet of structures, in the State of Illinois or approximately one for each four miles of roadway. Generally speaking, about 19 per cent of these have roadway widths under 20 feet but otherwise are in good condition. The larger portion of these are on roads on the tertiary system, and therefore are not affected by P.R.A. requirements; however, there are

slightly over 500 structures on secondary roads which represent approximately 2 per cent of the structures which do not meet the P.R.A. requirements. In other words, when improvements are proposed with F.A.S. funds in the vicinity of existing structures, the maximum number for which the P.R.A. would require reconstruction because of inadequate width would be slightly over 2 per cent. The effect is that if all F.A.S. funds allocated to Illinois were used adjacent to structures in this classification, at the present rate of construction, it would be over thirty years before reconstruction of all inadequate width bridges would be necessitated by this requirement, and within that time many would have been reconstructed for other reasons.

Incidentally, I might say that there are over 10 000 lineal feet of structures on the federal aid system in Illinois with roadway widths under 20 feet, and yet there are those who advocate discontinuance of the use of highway revenue for highway purposes because they say the present system is adequate.

Briefly considering construction standards it is difficult to see why anyone would suggest that standards of construction practice and field engineering, aside from design, should be any different from those employed on primary road construction; certainly, proper finishing of slopes and ditches on secondary roads will have the same effect on drainage and conservation as on primary highways, and surely the use of improper or inferior materials would have the same deleterious effect on secondary structures as on those on the primary system. It seems reasonable, therefore, that the present high construction standards on primary roads should be carried into the secondary road improvement. This, of course, does not apply to design standards. It is an established policy that specifications should be adhered to rigidly. In the case of low-cost roads there might possibly be some instances where the interpretation of such specifications would be more liberal, but there can be no relaxation of specification requirements. By that I mean that when a specification requires not more than 10 per cent passing a quarter-inch sieve, 11 per cent cannot be allowed, as that is not a matter of interpretation.

The subject of maintenance is perhaps one of the most controversial, some engineers believing that only minimum operations of absolute necessity should be performed, while periodic reconstruction of the surface and other features should be the medium providing a "traffic way"; others take the opposite view, believing that maintenance operations should embrace every minute detail to such an extent

as to render reconstruction unnecessary except when it is desired to change the geometric features.

It appears to me that state and county engineers in Illinois might more nearly approach the latter classification and we have found them, in general, most anxious to keep the roads in constantly good condition, and rightly so, because they are the target of public opinion. Often, however, when a county is pressed for funds, the maintenance standards decline. The explanation is given that this year most of its funds were spent on construction. While such construction may be ever so desirable and necessary, we cannot legally make allowances for such a situation for it is a well established policy of federal aid law that no construction be undertaken unless adequate funds for future maintenance be provided. Each and every improvement made with federal funds under the Federal Aid Highway Act is made under a formal agreement which provides for continued maintenance.

The coöperation of the states and of local governments in this respect has been so high that, to my knowledge, in only one instance in a distant state has there been approachment to invoke the provisions of the law which allows the P.R.A. to remedy unsatisfactory maintenance conditions with federal funds and deduct the cost from federal aid allotments, subject to later reimbursement and reapportionment.

A question often asked is whether the P.R.A. assumes maintenance jurisdiction over a surface which was constructed by a local government with its own funds on a grade built with the use of federal money. The Federal Aid Act of 1921 defines maintenance as: "The constant making of needed repairs to preserve a smooth surfaced highway." No distinction is made in that Act with respect to the local government's maintenance obligation when federal funds are actually paid out on only one stage of construction. Once the obligation is in existence the state cannot through its own act by constructing or improving a surface entirely with its own funds change the nature of that agreement. You may be sure, however, that inspecting engineers would in such a case use extreme care in reporting such a surface unsatisfactory.

Recent regulations with respect to construction of secondary roads carry the further provision that no projects contemplating maintenance by a county or other political subdivision shall be approved if any road previously improved with federal funds under the provisions of the Federal Aid Highway Act is not being properly main-

tained. We do not anticipate the necessity of applying that regulation in Illinois.

Finally, we believe that standards of design should adequately provide for traffic needs; standards of construction should be kept high; and that standards of maintenance should embrace the constant making of necessary repairs to keep a project as nearly as possible in its original condition or as subsequently improved, in order that each phase may provide satisfactory and safe service.

VIII. EROSION CONTROL AND LANDSCAPING

(Synopsis of talk illustrated with natural color stereopticon views)

Albin Gries*

The control of soil erosion on the highway roadsides is the first objective of roadside development in Illinois. This is accomplished by introducing vegetation as a ground cover on cut and fill slopes after flattening them where possible and necessary. Ground cover in the form of shrubs, vines, and grasses slows the rapid run-off during and after rains, and prevents most of the washing action which carries the soil away. Plants growing in the soil also help that soil to absorb a great part of the water, partly because of the slower run-off, and partly because their root action and decayed leaves make the soil more porous below and spongelike above the surface.

With the cut and fill banks protected against erosion much of the purpose of roadside development is accomplished: maintenance costs are reduced; most of the hazards of muddy pavements are eliminated; and the roadside with its cover of growing plants once more becomes a part of the surrounding landscape.

Many of our slopes are cut into or out of hard sterile subsoil, and it is not always possible to grow on them all the desirable native plants that would serve an ornamental as well as an erosion control purpose. In such locations lespedeza has been sown with good results where slopes are flatter than 2 in 1. Where slopes are steeper it still appears, after fully a hundred experimental soil erosion control plantings, that the black locust is the only desirable plant that will survive. Both plants have the ability to build up the soil and to make it fertile and friable, with the result that it will be possible to return to such plantings in the future and substitute more permanent or attractive material.

Last year 826 miles of roadside were planted with 31 000 shade and flowering trees and 558 000 shrubs and vines. Of this mileage 755 miles were planted as State Roadside Planting projects and 71 miles as Federal-Aid Roadside Improvement projects. This brought the plantings to a total at the beginning of this year of 350 000 trees and 2 500 000 shrubs and vines planted along 4664 miles.

The state program is concerned primarily with soil erosion control. The Federal-Aid projects are more complete roadside developments in

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FIG. 1. EROSION ON UNPLANTED CUT BANK

FIG. 2. EROSION CONTROL AND ROADSIDE DEVELOPMENT

FIG. 3. SECTION OF ROADWAY BEFORE PLANTING

FIG. 4. SAME SECTION OF ROADWAY AFTER PLANTING

which backslopes, fill slopes, shoulders, and ditches are regraded and seeded; and the plantings are planned with more thought given to the attractive appearance of the roadside as well as to the control of its erosion.

The highways constructed during recent years have much of the protection against soil erosion built into them. Also there has been a great improvement toward obtaining the best possible relation of

the highways to the surrounding countryside with the result that they require the simplest landscape treatment.

A growing appreciation for the recreational and scenic value of the highways has been met by the establishment of roadside picnic areas, turn-outs at scenic points, and the preservation of historic structures on or adjacent to the highway right of way such as the covered bridges near Chester and Oquawka. Travelers have been greatly served by having opportunities to pull off the roadways often to lunch or rest at some point with a commanding view or at some of the 300 picnic places that have been established to date.

In addition to the planting of new material a great effort is made for the protection of the existing trees and shrubs, especially in the control of the trimming for clearance by the utility companies of trees which happen to be growing too near their wires. Permits to do this trimming are issued only after the contemplated work has been investigated in the field by a landscape engineer, who later passes on the manner in which the work was done. The utility companies have gradually improved the methods by which many of our large trees have been disfigured in the past.

The Governor Henry Horner Farm Floral Contest is being carried out this the third successive year. The purpose of the contest is to encourage farmers along the highways to supplement the roadside planting with planting on their own farmsteads and on the abutting right of way. Last year eighteen hundred farmers entered the contest, and there was a very apparent improvement in the appearance of well-kept lawns, attractive flower masses, and orderliness of the grounds of these farmsteads along the highways. These frontages are as typical and as important in Illinois as is the native landscape into which our roadsides are to blend and to fit after six years of planting effort.

IX. LOOKING AHEAD

Frank T. Sheets*

Mr. Lieberman, gentlemen, and old highway friends: It is like coming home to come down to this meeting. I want to thank Director Casey for his gracious remarks regarding my good friend, Mr. Lieberman, and myself, relative to the part we have had in the development of Illinois highways.

When the invitation to come here on this occasion was presented to me, I had been declining speaking engagements of all character because of business pressure; but this invitation I could not resist. I am happy, beyond measure, to be with you. I only wish that I could on this occasion visit personally with each of you whom I have known for so many years, and also get acquainted with the newcomers in the ranks.

I want to say here publicly that I think it is to the everlasting credit of Governor Horner, the Director of the Department of Public Works, and Mr. Lieberman, that there are present here today from the Illinois Division of Highways so many of those who have been consecrating their lives to the development of Illinois highways for so many years. It is characteristic of the policies that have prevailed in Illinois highway development since 1906.

Being an old highway engineer, from the standpoint of years of service, perhaps I can be pardoned for referring to history for a few moments. Back in 1906, Illinois began to stir from her stupor of mud. That was during the administration of Governor Deneen when the old State Highway Commission was created and began to tell the farmers that it was a good idea to drain a dirt road and to drag it before it dried out or froze. We built a few bridges around Illinois as object lessons of good construction. The state commission had no direct appropriation for construction—only enough to give engineering service to local highway officials.

Out of that grew the formation of the State Highway Department and the beginning of state aid for the construction of a state aid system of roads. This came about during the administration of Governor Dunne. The good ideas that had developed during the preceding administration were carried right on and amplified during that administration, and we made substantial physical progress in road building and developed a general appreciation for better roads and bridges.

*President, Portland Cement Association, Chicago.

Then followed the 60 million dollar bond issue act and the prosecution of that program of primary highway construction during the Lowden and Small administrations. During this period came the 100 million dollar bond issue act which provided for an enlarged trunk highway system—the bonds in both cases to be retired by means of motor license fees. During Governor Emmerson's administration, this work was continued, additional funds being provided by means of the gasoline tax. From about 1920 on, federal aid also helped with highway financing.

The current administration has continued a sound policy of highway development and it is to the everlasting credit of all these administrations that Illinois has this enviable record of 34 years of sanity in highway financing, administration, and development. We have a lot to be proud of in Illinois. I travel a lot, and I have seen a lot of highways throughout the country. I know of no state that holds a more advanced position in highway development than does good old Illinois. I am very proud to have had a part in some of this work.

When Professor Wiley invited me to make this speech I assumed that I could talk to you extemporaneously as in former years, and say just anything I had on my chest. I accepted the invitation in that belief, only to be confronted by a letter just yesterday to the effect that I was expected to produce a manuscript. Well, gentlemen, I don't have one with me so this informal talk must serve for the record.

A lot of people are today prone to criticize the highway engineer for past work. I speak of those who now look back to our older work and say that the early roads don't measure up to the standards of today's traffic demands, and then deduce that the engineers who built the system were lacking in vision. To that I cannot subscribe.

I think the American highway engineers and particularly the Illinois highway engineers have done a very fine job in producing the highway development of this and other states. I don't think we have anything to apologize for. Somebody made a remark this morning that went home with me. He was discussing the difficulties of getting rights of way and the fact that the engineer had to be so far ahead of public sentiment regarding location and right of way acquisition that he was in danger of being hung.

I know that is true, because I have been placed in such a position on numerous occasions by trying to do things in highway location which consideration for the future demanded. Take the heaviest traveled road between Springfield and Joliet, for example. We were asked by the local people to stairstep that road through the country

between Springfield and Joliet, introducing some 30 miles of extra distance and crossing and recrossing the C. & A. Railroad some 31 times. We couldn't see that, and figuratively speaking, we fought, bled, and almost died by demanding a diagonal location through that country that saved that mileage and saved those grade crossings. Local people started proceedings and took us clear up to the State Supreme Court on the question of the legality of such a location. We won out finally, and the road has been a serviceable highway, but it could have been anything but that. Mat Fleming, sitting there in the audience, made some of the surveys for that road and knows of these difficulties.

Such are the problems the engineer in responsibility must meet, and whenever we get to the point where we are not willing to step out ten years in advance of public sentiment in location matters and take the grief that goes with it, just then, I think, we can be indicted for short vision. Until that time I think we can rest rather complacently upon the accomplishments of the highway engineers of this state.

But we can't live in the past. I have a young friend in our organization by the name of George Bartlett—many of you know him. He is 82 years old. Recently, when we had our district engineers from all over the country together for a meeting to discuss some of our problems, Mr. Bartlett made a speech to them in which he expounded this philosophy—that the minute we can't adapt ourselves to changing conditions and can't change our thoughts accordingly, we have started to die. Well, if a man of 82 can expound that philosophy, I guess we all can afford to follow it.

Therefore, I think we have to look forward, not only in Illinois, but in other states, to some rather definitely changing conditions. You know in the old days we tried to get Illinois out of the mud. Now our big problem is to get Illinois out of traffic congestion. In the old days our major highway problem was out in the country and now it is getting back into the cities.

Get me right, I am not favoring any one class of citizens in Illinois, or any one class of roads. I am interested in them all, because it is right and essential that all people get a square deal; and so far as any commercial interest we may have in highway development is concerned, we have just as much interest in the road leading up to the mailbox on the rural route as we have on express highways in the Chicago metropolitan area. We have products adapted to both. So I

think I can speak of these things without the charge of being prejudiced.

We must do something about the traffic jam, delay, and hazard in the Chicago metropolitan area, and I know that anyone who has thought about the problem realizes this. I remember that back in 1928 we saw the problem coming. We got busy in the Illinois Department and in coöperation with the local agencies, laid out a program and brought about the widening of the main radial highways leading out from Chicago, to at least four lanes for about 30 miles. We also speeded up a program of grade separations with railways and at important highway intersections. This gave great relief, but traffic congestion then became concentrated at or inside the city limits whereas before it had been distributed somewhat outside.

This and other experiences lead me to say that we are never going to have a real highway system in Illinois or in any other state until we recognize that there are no arbitrary civic or geographical boundaries to the flow of traffic, and that the artificial barriers imposed by the respective jurisdictions of the cities, the county, and the state, must be removed so far as highway financing and administration are concerned, if we are to enjoy the ultimate realization of free egress and ingress, free flow of traffic, wherever the traffic wants to move. Toward this end we must use the best engineering and legal thinking to insure equitable financing and proper construction.

We used to think, back in 1920 to 1923, and even later, when we were building highways at the rate of a thousand miles or more a year, that pretty soon we would have our system finished and that then we could all take a vacation. It has certainly not turned out that way, because Old Man Traffic has grown beyond anyone's dreams, and the roads that were adequate are now proving to be inadequate. Starting from our focal centers of traffic in the Chicago metropolitan area, the St. Louis metropolitan area, and other large cities, we must now begin to provide multiple pavements on our main routes. I think this should come by stage construction as the surveys show additional traffic lanes to be needed. Some roads also need to be realigned and some need to be reconstructed because of the terrific overloading they have taken.

This primary system in which we have invested the state's money—and it is one of the best investments the state has ever made—must be kept up to modern demands, because, unless we do so, we are cramping the efficiency and earning capacity of that system. Everybody is interested in the main trunk highway system, whether he lives

on a farm or in Chicago, or in a downstate large city, or in a village. That system of roads is everyone's system, and when we let it deteriorate or become obsolete it will be a bad thing for everybody in the state.

We must also plan development and paving of the state aid or main county trunk highway system. It will never be fully completed because we will be forced periodically to reconstruct sections of those roads, or, as traffic may demand, step up the degree of improvement. There also remains the problem of providing an all-weather road past every farm gate. This will ultimately be solved.

Those are some of the things we have ahead of us. The problems facing us in Illinois today are just as large as those that confronted us in 1920—perhaps more difficult to meet now, because the all important right of way problem is much more acute than it was in the days of 1920. Then anybody in the state would practically give his eye teeth to get a road built in his community. Needed land was easy to acquire. Now local people have the roads and are satisfied. When you want a right of way for modernization, widening, and what not, they say, "Well, go ahead and pay for it—that is all right with us, but the present road serves our needs." That means that the right of way problem is more complex. It has grown until now we find it holding the center of attention in the halls of the Congress of the United States. That is how serious this problem of securing rights of way for needed improvements has become.

How are we going to secure rights of way and finance this badly needed work? I think we can do so only as we plan intelligently. I have no specific plan to propose today. I offer the key to evolving a plan.

We have been through a lot of planning in Illinois. A lot of you men have been through it with me. When we had gotten pretty well along with construction of the 60 and 100 million dollar bond issue systems, and when folks began to see that the first paving of that system was pretty well assured, we began to hear rumblings from Chicago saying, "We want more state highway money spent in the Chicago area." We heard from other cities, "We want more of the state's gas tax spent in the cities." The rural people and organized farm groups demanded greater consideration for county and township roads. Here were as many ideas as there were talkers. It seemed to me that unless we watched our step, we might see Illinois give birth to a highway monstrosity.

At about that time the Bureau of Public Roads first came forward

with the idea of rational planning surveys—factual surveys on which to base sound highway thinking. A. R. Hirst of the Bureau came to me and suggested that the Bureau would be glad to coöperate with us on making factual surveys. I was glad to grasp that opportunity.

Accordingly we went ahead and made a state-wide traffic study, economic surveys, etc. But it seemed to me, as we were undertaking those studies, that we could have enough facts to choke a school house and they wouldn't do us much good unless we had the medium established for converting those facts into a plan that the public would accept.

So we conceived the strategy of having the General Assembly authorize the appointment of a future road program commission, and, I think, with some political acumen, we suggested that the commission should have on it five members of the Senate, likewise five members from the House—and of those five, three should be Republicans and two Democrats—now it would be three Democrats and two Republicans. The main thing was that there was a bipartisan representation from the Senate, and from the House, and to round out the commission we recommended five citizens at large. Of the latter, one was Mr. Anderson, County Superintendent of Highways of Williamson County. Another represented the State Chamber of Commerce, another the Chicago metropolitan area, another the farm group, and so on. Thus the future road program commission was representative of the legislative branches of the government and of the citizens at large. The Director of the Department and I, as Chief Highway Engineer, served as ex-officio members.

We called that commission together. I will never forget its first meeting. There were as many different ideas as there were commissioners. They were all sincere in their ideas, and it seemed to me the only smart thing was to suggest that they adjourn until we got the fact-finding studies finished. They accepted the hint.

When the facts were available and assembled in understandable form, the commission renewed its deliberations. The interesting thing to me was that with all these divergent groups and interests represented, a unanimous conclusion was finally reached. At first some of the farm element thought we ought to take one-third of the gas tax and spend it on township roads, carrying only 10 per cent of the rural traffic, when urban people were contributing 80 per cent of the money. On the other hand, some urban minded people wanted the money turned over to the cities without any restrictions on the use of the funds and with no state supervision. With all of these divergent

opinions the final outcome was complete harmony in the proposal of a program that was sound because it was predicated on facts.

That commission got its report out late in 1932 when at the general election the political complexion of both the administrative and legislative arms of the government was changed. What happened? Early in 1933 this report was presented to the General Assembly. Here was a commission set up under a Republican regime, under an act passed by a Republican dominated legislature, a commission appointed by a Republican Governor, which made a report of its findings to a General Assembly in which the balance of power had definitely changed to Democratic. Also there had come about a Democratic administration of the Governor's office, a Democratic regime in charge of the administrative affairs of the Highway Department. Yet in spite of these complete changes of administrative and legislative personnel, this commission's report was so well grounded on facts, and was recognized as being so eminently fair, that its recommendations, translated into legislative bills, were adopted by an almost unanimous vote of both the Senate and the House and were approved by the Governor. This constructive action has shaped the financial and administrative policy of this state for the past eight or nine years. That is a triumph, it seems to me, of two things: First, consecration to the ideal of good public service on the part of administrators and legislators of both political parties; and second, a triumph of the principle that if all of the facts are laid on the table, agreement between conflicting points of view can be had—a triumph of truth, if you might want to put it that way.

It has been my experience that about every ten years in Illinois we have had to reorient our highway thinking. We started in 1906 with the old highway commission giving advisory service to local officials. Ten years later came the evolution from state aid construction of county roads to adoption of a state highway system, totally financed by the state. That occurred in 1917 with the passage of the first state bond issue act. Ten years later came the future road program commission and the adoption of its recommendations; and now nearly ten more years have passed and it's time to resurvey the problems before us. There can be no better approach than to repeat the last successful method of reviewing the facts and determining what the policy shall be.

Fortunately for our state, Mr. Lieberman, our able chief highway engineer, has coöperated with the U. S. Bureau of Public Roads in making, in a much more extensive manner even than before, the

planning surveys and the factual studies which are essential to a redetermination of a sound future Illinois state road program. With this information available, we have all the tools required to shape our future highway structure in Illinois. We have in our tool kit the broad sledges and cross-cut saws that are necessary to shape the broad policies, and also we have the micrometers and fine tools for designing specific projects and for refined operation of the highway system. All the data obtained are valuable information.

Our big problem now in Illinois is to get these planning tools used, and a constructive future program adopted. My prayer is that while this information is fresh and usable, we may take the steps in Illinois to bring about a sane consideration of these major future road problems that I outlined briefly in my early remarks, and to evolve a solution for them that is fair to every citizen in the state, no matter where he lives—in Chicago, downstate, or on the farm.

Now we are in the strife of the perennial political campaign. I do not know who is going to win. Someone will win. We will have a new Governor, be he Republican or Democrat. In either case, changes in administrative personnel may come. I hope that the new Governor, whoever he may be, will have the vision to perpetuate the able engineers in our highway service, and also to take a constructive position on these all important questions relating to our future highway program.

I would like to see us start now to get ready for that change and for the education of those who may come into executive and legislative responsibility so that the right thing may be done for this highway baby of ours—so that its limbs will not be twisted into malformations, its growth stunted, or its health impaired. To this end, I believe we could well adopt the method which proved so successful in the past, and seek at the next session of the General Assembly adoption of legislation insuring the formation of a future road program commission to sit down and again study our highway future in the light of all these available facts.

Unless this is done, I fear that we are going to see moves come about which are perhaps well-intentioned but probably ill-advised. Everyone has self interest in mind and as long as he thinks his self interest conflicts with the other fellow's, he is for his own; but we can show by such studies and by such a fact finding approach that there are no conflicts of interest if we adopt an equitable solution for Illinois' future highway problems. That is the thing I would like to see done. That is my challenge, if I may term it so.

As an old timer, I would like to throw out to this group a challenge to work toward this end. There is no other group more responsible for the future health of the Illinois highway situation. You county men who have the confidence of your home folks, and all of you state men in executive responsibilities can have a great influence in steering our highway affairs along a sound course. Let this group of Illinois highway engineers resolve here today that they will do all within their power to keep this highway situation guided by straight thinking; that they are not going to permit this unbroken chain of logical highway development to finish up on the rocks of ill-advised or selfish action. We must exercise the leadership, we must guide this thing, and we must clear the thinking of those who are less informed. No more courageous nor public spirited stand could be taken than to dedicate ourselves to seeing our highway affairs steered straight. If you engineers and officials don't do it, someone else will; and a bunch of bungling amateurs could quickly wreck our highway future by ill-advised action. Let's not fail the people of Illinois. Let us not try to drive, but rather to lead them into the land of fact and understanding. Then our highway future will be secure.

I have talked enough. I have enjoyed this opportunity. This reunion with you has meant much to me. I thank all of you most sincerely.

X. ROLE OF HIGHWAYS IN NATIONAL DEFENSE

Charles H. McNutt*

To be asked to tell this assembly, in the few minutes allotted to me, the importance of highways to National Defense is very much like being asked to explain in one sentence what function the blood vessels of the human body play in the act of hurling a baseball or, if we *must* be "defensive," in the act of catching a baseball when another hurls it.

Fortunately the fundamental necessity of highways for troop concentration and movement, movement of weapons and material, ammunition, food, fuel and oil are so well known generally that I'm sure I do not need to prove or elaborate that point before such an assemblage as you gentlemen present. Roads have always exerted an important influence in military campaigns—from ancient times to the present—from the Appian Way of the Caesars to the A———— Way of Hitler.

The history of the American Army and its part in our national expansion is closely linked to the road system of the United States. The National Pike was built by the War Department to enable the defense of our then western frontiers. But this and others of the early roads built by the Army for defense during the frontier days later became important trade routes and, as the population increased, civil rather than military needs became of primary importance.

Recent evolution of warfare to the modern blitzkrieg type, and to the conception of "total" war, wherein every resource of the nations involved must be brought to bear completely and effectively, has brought a new significance to the role of highways to warfare generally—and to our National Defense in particular.

Modern warfare is characterized by rapid concentrations of men and weapons, shifting of reserves with lightning swiftness and sudden thrusts in force when and where least expected by the enemy. Of course, without modern all-weather highways this type of warfare would not be possible. The potentialities of high speed mechanization would be lost.

Contrast our most recent illustration from the laboratory of war—Germany's invasion and conquest of Poland and, even more recently, Russia's invasion of Finland. In the first of these illustrations Germany's superb system of military highways, just completed,

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enabled the lightning concentration and attack which obliterated the great Polish Army in less than three weeks. In the second of these illustrations the lack of adequate good roads in both Russia and Finland bogged down any concerted operation of the vaunted Russian mechanized military machine and converted that operation into a stalemate which Russia could break only because of her overwhelming man power. While it might be argued that Finland's lack of good roads was her best defense against the high speed mechanized attack, we cannot draw any analogy between tiny Finland pitted against her great neighbor and any problem our own National Defense may be called to meet.

We need not expect a mighty neighbor to strike us without warning and overwhelm our country in a day. With our enormous area and comparative isolation from other great powers *that* could not happen. When an enemy does come, he must come a long distance by land or sea or air and it is to our highways that we must look to carry us to meet him wherever and whenever he appears.

With our long coast lines and land borders with their many vulnerable points it would be impracticable to maintain adequate fixed defenses at all points of possible danger in preparation against invasion. We could not afford and, thanks to our highways, feel sure we will never need a complete "ring of steel," a Maginot Line, for our defense. We do and must rely on the highways you gentlemen provide to enable our quick concentration and movements to points of danger.

I wish to stress the fact that our plan of National Defense is based primarily on concentration of men and weapons within strategic areas and upon our measured ability to shift these forces quickly and effectively to meet any threatened attack. Just one thing makes this plan possible—our modern "all-weather" highways. This and this alone gives us a sense of assurance in our plan of National Defense. And as our system of civil highways is constantly improved and as it stretches its web further and further so does the sufficiency of our plan increase.

And I would like to point out also that, in enabling us to move rapidly in force over long distances, an adequate highway system greatly reduces the cost of National Defense and thereby lightens the burden of taxation for this purpose. Our ability to move rapidly makes unnecessary the many small and uneconomical border posts and stations previously maintained. A good illustration of this may be seen in our defense against possible attack through our southern border. Whereas, before the advent of mechanization and good roads over

which it could move swiftly, we had to maintain more than a dozen border posts, we now garrison only a very few and these well back from the actual frontier. This concentration in a few garrisons promotes economy, efficiency and effectiveness in training.

Finally, as citizens and highway builders of Illinois, I am sure you gentlemen are especially interested in the role your own splendid highways play in the scheme of National Defense. Although this role may not be as immediately apparent or as spectacular as that of—say the roads leading to and along our coastlines, it is nevertheless vital.

These splendid highways you gentlemen have built and are building for peace-time traffic are an absolutely vital asset in our plan for National Defense. Perhaps the best way to make this instantly apparent is to ask you to visualize for a moment what our national situation would be if we had *no* dependable all-weather highways running East and West across this great State of Illinois –no dependable transcontinental artery between the junction of the Ohio and Missouri Rivers at Cairo and the Great Lakes! Our ability to shift our forces, and all motorized transport of munitions from coast to coast would then be limited to the few first class highways leading to the bridges at Memphis, Baton Rouge and New Orleans. Without the many fine routes across the State of Illinois at our disposal, the Mississippi River would then constitute a threat to our mobility which would greatly increase the minimum peace-time military establishment necessary for national security. And then, aside from any consideration of transcontinental movements of large military forces, I am sure you all know from your daily contacts with industry the prime importance of your highways in handling the normal flow of goods within and across Illinois. I am sure, too, you must realize how the demands of war would increase the burden on these roads and how important the successful carrying of that burden would be to the national effort. A break down of our roads would inevitably mean a break down of our defense.

I have pointed out that adequate roads are now, as never before, a vital asset in our National Defense and that provisions for their utilization form an important consideration in the Army's planning. That, also, reliance upon the adequacy of our highways permits the Army to employ a plan for National Defense which is compatible with economy. And finally, I have called attention briefly to the vital role your own highways in the State of Illinois play in this plan. The fine highways of your state, developed by your skill and untiring efforts, constitute a contribution of incalculable value to the nation's welfare in war as well as in peace.

I thank you.

XI. SOLVING SOME STREET PROBLEMS IN THE CITY OF PEORIA

Thomas E. Wetzler*

The proposed Elliott Street extension in Peoria, a model for which was built to a scale of 20 feet to the inch, is part of a street improvement program put underway by the Department of Public Works in the past three years to relieve traffic congestion throughout the city. This link, when completed, will serve to divert much of the cross-river traffic from the large industrial plants in East Peoria, now going through the congested business section, and take this heavy traffic up the steep hill that lies approximately one mile from the Illinois River. A large percentage of the residential district of Peoria is located in the bluff regions, and it is in this general direction that the city is developing.

Before going into details regarding this new extension it might be well to explain the reasons for such improvements in Peoria. The main business district is concentrated in a very small area, whereas the city itself is sprawled along the river in both directions for several miles, as well as climbing up the bluffs where, as before stated, the larger portion of the residential district is located. To further complicate matters thousands of Peoria residents work in the industrial plants located up and down the river on the Peoria side as well as in plants on the East Peoria side including the huge Caterpillar Plant.

The 4-lane Cedar Street Bridge in the south end of the town carrying 17 000 vehicles per day and the 2-lane Franklin Street Bridge in the center of the town carrying 23 000 vehicles per day are the only bridges into Peoria from the east side of the river. There is an old bridge at the north end of the city, which carries a very limited amount of traffic. The new north side bridge, construction of which will start this summer, and which is being built by the State of Illinois, will carry some of the traffic now using the Franklin Street Bridge. The state will also construct a belt line around the city to the northwest starting at the Peoria end of this bridge.

The traffic using Franklin Street Bridge is discharged into the business district. This traffic, along with the traffic moving east and west through the business section, causes great congestion. The majority of this traffic eventually goes up the hill to the bluff residential section.

*City Engineer, Peoria.

FIG. 1. MODEL FOR PROPOSED ELLIOTT STREET EXTENSION IN PEORIA

In the original town of Peoria, as laid out by William Stephen Hamilton, son of Alexander Hamilton, all streets are 100 feet wide. All these streets have a 60-foot pavement. Mr. Hamilton was a man of vision and what would be now called a good planning engineer. He apparently visualized the need of wide streets. This original town of Peoria was laid out parallel to the river which runs in a northeasterly-

southwesterly direction. However, subsequent sub-dividers did not follow this original plan, and the first subdivision was laid out square with the world thereby making multiple intersections in the now business section.

In trying to untangle this snarl, the first step was to widen and improve Elliott Street a distance of 2876 feet. This street is a part of the route leading from the Cedar Street Bridge. This route, when completed, will lead up the hill and through the northwest section of the town and will draw a large percentage of the traffic now passing over Franklin Street Bridge. It also will pick up a large volume of traffic headed for the bluff by way of the business district. Elliott Street was paved 54 feet wide and the end of this pavement is the beginning of the extension which it is proposed to build this summer, and which is the most important section in this whole route.

At the other end of the Elliott Street extension traffic will follow the present route which runs three blocks north and two blocks west, and then again turns north on University Street which was improved last year. The alignment of the Elliott Street extension is a tangent which bears 30 deg. Northwest. In the future this tangent will be extended across the previously mentioned 6 blocks to University Street. The Elliott Street extension rises from the valley on a 6.48 per cent grade for a horizontal distance of 2000 feet. Three hazardous grade intersections will be eliminated by closing one cross street, and by carrying one street under and one over this improvement.

The pavement across the valley before reaching the hill will be placed on a fill confined between two cantilever retaining walls of 18 foot maximum height.

Two plans are suggested for that portion of the improvement from the point where the roadway enters the hill to the end of the section, one consisting of an open cut, sloping the banks from the sidewalk on a two-to-one slope. The second plan is to build retaining walls the full heights of the cut. While the first plan would be simple and have more natural beauty, the high price of property which would have to be taken and future maintenance of the sodded slopes makes it much more expensive than the second plan.

The entire extension has a 6.48 per cent grade and rises 97 feet from its beginning in the valley area to its termination at the top of the hill. The maximum present grade is 18 per cent.

It is estimated that the cost of this improvement, including the property to be taken, will be $250 000. The roadway is to have 2 11-foot lanes divided by a 3-foot strip 6 inches high; 5-foot sidewalks

including width of curb will be provided on each side. The roadway will pass under Moss Avenue and over Fifth Street. Fifth Street will be opened into Seventh Street, thereby providing a through street from Franklin Street west to the airport, and also the cut off to State Route 8. The entire project is to be financed by Motor Fuel Tax funds.

Franklin Street, which forms the west boundary of the business district, starts at the Peoria end of the Franklin Street Bridge and runs northwest one block then north to the intersection of Perry Street and Seventh Street.

Franklin Street crosses Washington, Adams, and Jefferson Streets, which carry a large volume of traffic, and which unload a large percentage of their traffic on to Franklin Street.

Madison, Monroe, and Perry Streets come into Franklin Street from the northeast while First, Third, Fourth, Fifth, Sixth, and Seventh Streets come into it from the West. The traffic at Washington, Jefferson, Madison, and Monroe Streets is controlled by three-phase signals, which are so timed as to dovetail into the two-phase signals in the downtown business district.

Franklin Street was widened from a two-traffic to a four-traffic lane street, in addition to two parking lanes. An 8-inch concrete pavement, including curb and sidewalk, was laid from Washington Street to Monroe Street.

Ornamental lights were placed on each side of the street, which provide adequate illumination. The suspended type luminaires with refractors and reflectors were used, mounted 22 feet from the pavement. Small islands were placed at the Jefferson Street and Madison Street intersections. These islands are 3 feet 6 inches wide, 6 inches high, and 17 feet long. They serve two purposes, one to lane traffic and one to provide safety for the pedestrian in crossing the street.

Twenty-nine thousand vehicles pass through this intersection in 24 hours. Automobile accidents have been cut 50 per cent since the islands have been in use, and pedestrian accidents have been cut 100 per cent. The traffic and parking lanes are marked off by a four-inch trowel mark. Just after the slab was broomed this line was troweled smooth. This line is plainly visible day and night. This method of laning was used on all our subsequent streets with equal success. This improvement was financed by special assessment and M.F.T. funds.

Hamilton Street on the east side of the business section runs from Washington Street in a northwesterly direction to the top of the bluffs, and is one of our main arteries to the bluff residential district.

We improved this street from Monroe Street up to the top of the bluff, where it connects with North Street and with Columbia Terrace, which runs west. U. S. Route 150 runs out Hamilton Street to Columbia Terrace, then west to University Street, which was mentioned before in connection with Elliott Street extension.

As stated before, Franklin Street was improved to Monroe Street. Monroe Street was improved to Abington Street. Monroe Street crosses Hamilton Street at a distance of two blocks from Franklin Street. Traffic, therefore, can flow from Franklin Street Bridge over new modernized streets by way of Franklin Street, Monroe Street, and Hamilton Street to the bluff section, or by way of Washington Street and Hamilton Street, thereby avoiding the congested business district. The improvement of Hamilton Street consisted of two traffic lanes and one parking lane on each side of an 8-foot median strip. The concrete slabs are 8 inches thick. In the center of the median strip is an ornamental lighting system consisting of steel poles placed approximately 100 feet apart, and carrying an arm each way from the centerline.

From these arms is suspended a luminaire containing a refractor and reflector. The light source is four feet from the center line of the street and 22 feet from the pavement. This system provides ample lighting on the pavement and sidewalks, and at the same time throws very little light on the abutting buildings. As far as we are able to find out this lighting system was the first paid for out of State Motor Fuel Tax funds.

Traffic markers of white cement were used to divide the lanes, and a white cement curb on each side of the median strip was provided. This curb is 6 inches high and 9 inches wide curving back from the pavement. Cars being crowded can roll up on this curb without damaging car or curb.

Pedestrian safety islands are placed at each intersection at the ends of the median strip. These islands are also covered with white cement while the balance of the median strip is sodded. The maximum grade is 8.6 per cent. Vertical curves made necessary by the cross streets were designed to ride comfortably at 45 miles per hour.

From Franklin Street to Abington Street, Monroe Street was improved 50 feet wide for a distance of 8400 feet.

From Franklin Street to a block east of Hamilton Street, which comprises three blocks, this street was made 60 feet wide with a 3-foot wide and 6-inch high concrete median strip in the center. In the center

of this median strip ornamental lights of the same design as those on Hamilton Street were provided.

Our new post office is on the south side of Monroe Street, and extends one block west from Hamilton Street. The street car tracks were removed from this street and a cement bound macadam pavement varying in thickness from 6 to 7 inches was placed on the original concrete base after the bricks were removed. With the exception of the median strip and ornamental lights this project was built by the W.P.A. and a small amount of Motor Fuel Tax funds.

It is proposed to extend Monroe Street in the future to connect with North Jefferson Street at a point two blocks south of the intersection of North Jefferson and North Adams Street. These two streets really do not intersect, but Jefferson Street running parallel to Adams Street further west comes into Adams Street at a 20 deg. angle. The State Route 29 coming east on Jefferson from Hamilton Street continues east on Adams Street. From the point where Jefferson comes into Adams Street east to Eureka Street a distance of 4500 feet, Adams Street is now being widened to four-traffic lane and two parking lane street. The existing 20-foot concrete slab in the middle of the street will remain, and an 18-foot concrete slab 8 inches thick will be placed on each side. Eureka Street is two blocks west of Harvard Street. The proposed new bridge to be built by the State crosses Adams Street at Harvard Street. North Adams Street presented a storm water problem. The water comes down the cross streets from the hills and must be taken care of by the Adams Street sewers. Three lines of sewer run to the river, a distance of half-a-mile. The water will be picked up at each street intersection by 4 large inlets placed on the bluff side of Adams Street. This is entirely financed by Motor Fuel Tax funds.

When the new north bridge is completed, the widening of Adams Street from Eureka to Lorentz Street, a distance of 3 blocks, will be completed.

At the present time the state is widening the road east from Lorentz Street, making a four-lane road with a median strip 4 feet to 30 feet wide. This is Route 29 which runs to Chicago by way of Chillicothe, LaSalle, Ottawa, and Joliet.

Abington Street, which runs from North Adams Street in a northwesterly direction to Prospect Road, is another street going up the hill and is an important north end-east bluff connection. It crosses North Jefferson, North Monroe, and North Perry Streets. These

streets will discharge traffic, going to the east bluff from the downtown district, into Abington Street. The contract for this improvement will be let in a few weeks. Abington pavement will vary from 56 feet wide to 40 feet wide. The 56-foot width provides four 10-foot traffic lanes and two 8-foot parking lanes, while the 40-foot width provided four 10-foot traffic lanes with no parking lanes. Parking will be prohibited on this part of the street. Maximum grade will be 10 per cent. Special assessments and Motor Fuel Tax funds will finance this improvement.

North Jefferson Street for three blocks east of Hamilton Street was a 40-foot street. From this point east to where Jefferson comes into Adams Street was widened to 56 feet and paved in 1936. We widened the previously mentioned three blocks to 59 feet. A 3-foot by 6-in. high concrete median strip was built in the middle of the street, leaving two 28-foot pavements on each side. Ornamental lights similar to those on Monroe Street were placed in the center of this 3-foot strip. This improvement was entirely financed by Motor Fuel Tax funds.

On both Monroe Street and Jefferson Street we extended the 3-foot strip across the cross walk at the intersections. This provides a pedestrian island, and also prevents cars from cutting the corners on left turns.

Both Monroe Street and Jefferson Street, where we placed these 3-foot strips, are close to the business district and are working very satisfactorily.

Jackson Street is two blocks east and parallel to Hamilton Street. It runs from Washington Street northwest to Glen Oak Avenue. Washington Street is our first main street from the river and runs parallel to the river. It is paved 60 feet wide and carries a heavy load.

Were Jackson Street widened and repaved it would receive a great amount of traffic from Washington Street routed to the east bluff. Glen Oak Avenue runs northeast and rises from Jackson Street to the top of the bluff, following the brow of the bluff for a distance of 3000 feet, then is dropped down the hill reaching a low point at Spring Street, then rises again to the top of the bluff, where it connects with Prospect Road. Prospect Road runs in a northerly direction out into the suburbs for a distance of two miles, carrying a heavy load due to the fact that it is the farthest street east on the top of the hill. This street will have to be widened and paved in the near future. Spring Street runs northeast from North Adams Street to Glen Oak Avenue and picks up traffic for the east bluff from Adams, Jefferson, Madison, Monroe, and Perry Streets. It will have to be widened and paved in

the near future and continued in a straight line to Wisconsin Street, which will be an important North Street in the future.

Glen Oak Avenue was improved from a 24-foot pavement to a 34- and 36-foot pavement, from Jackson Street to Spring Street. Several streets running north dead end at Glen Oak Avenue, these streets feed into Glen Oak Avenue causing it to carry a large volume of traffic. St. Francis Hospital, the largest hospital in Peoria, is on the river side of Glen Oak Avenue at the top of the hill coming up from Jackson Street. The hospital grounds are higher than the street, and it was necessary to build a retaining wall back of the sidewalk ranging in height from 3 feet to 5 feet. The ground was terraced up to the building from this wall. The hospital donated a large strip of ground so that we could reduce a 40 deg. curve to a 2½ deg. curve, thereby simplifying the movement of traffic at this point. This improvement was financed by special assessment, P.W.A. and Motor Fuel Tax funds.

University Street, referred to in connection with the Elliott Street extension, was improved with a concrete pavement 36 feet wide for a distance of half-a-mile. A large storm sewer was part of this improvement. University Street was financed entirely by Motor Fuel Tax funds.

All these improvements were made in the last two and one-half years. Along with the foregoing major street improvements, 50 residential streets were paved—about nine miles altogether. These streets were paved with concrete 30 feet wide, except 4 which were paved with black top. Some of these streets were paved with 45 per cent P.W.A. and 55 per cent special assessment, some 100 per cent special assessments, and 4 were paved 100 per cent with cash collected by the property owners, but were built under our supervision and specifications. Illinois State Highway Specifications are used on all our improvements. Altogether $267 000 of special assessment bonds were floated. The quotation to the contractors ranged from 97 to 98½.

Jefferson Street from Hamilton Street to Franklin Street and from Franklin Street to Lincoln Avenue is being considered seriously for improvement. Lincoln Avenue is about 5400 feet southwest from Franklin Street and Hamilton Street is 4 blocks from Franklin Street on Jefferson Street.

South Jefferson Street is improved from Lincoln Street to Western Avenue, a distance of about a mile. The proposed improvement when completed would see Jefferson Street modernized from Western Avenue to North Adams Street, a distance of about 5 miles. Western Avenue in the southwesterly part of town is a very important street which runs

from Washington Street north across the valley a distance of 1½ miles to the foot of the hill, then up to the top of the bluff.

Financing street improvements is one of the most important parts of the job. Another thing which plays an important part is the coöperation of the State Highway Department. We have had this coöperation at all times from Mr. Ernst Lieberman, Chief Engineer, George Baker, Engineer of County Roads and City Streets, Theo. Plack, District Engineer, Don Walker, District Engineer of County Roads and City Streets, and from all the other engineers in the Highway Department. Our relationship with the P.W.A. engineers was also beneficial to us, and left many pleasant remembrances.

We have only scratched the surface. It would require at least 5 million dollars to complete a program that would allow the traffic in Peoria to flow swiftly and safely without congestion.

XII. PLANNING PROGRESS IN DECATUR AND MACON COUNTY

Alan N. Buck*

City and regional planning first gained interest of the citizens of Decatur in 1919. At that time Decatur was a city of about 44 000 inhabitants, and Macon County had a population of approximately 65 000. Macon County is located almost at the geographical center of the State of Illinois, and it is in the center of a most fertile country of great potential wealth. The City of Decatur is located almost at the geographical center of Macon County, and the effect of railroads centering here from many directions, together with the agricultural wealth, has made continuous growth a certainty.

In 1919 thirty of the prominent and far-sighted citizens formed an unofficial planning commission. They retained a planning consultant who prepared the Decatur plan of 1920. The engineer's fee was raised by private subscription. A plan was prepared and was printed in about 200 volumes of 175 pages each. This plan was illustrated with plats, pictures, diagrams, etc. Thus the ground-work of community planning in Macon County was established. However, for several reasons, among which was the fact that there was no State Planning Act at the time, and for various economic reasons, not much progress was made in the carrying out of the original plan. However, there would have been many more difficulties in the way of the progress of Decatur had it not been for this plan, and by complete adherence to a comprehensive city plan the existing difficulties could be greatly eliminated, and mistakes avoided in the future. Therefore, the carrying out of many of the recommendations of the plan, although it might be a small percentage of the whole, was well worth the original investment of 1920.

In January of 1937 it was decided by civic leaders that it was time to revise the plan of 1920. Therefore, after several conferences of all the taxing agencies, which included county government, city government, township government, school board, park board, and sanitary district, they jointly financed the preparation of a new city plan. In general, this plan did not deviate from the original as far as the aims and objects were considered. However over a period of 18 years the community had experienced such rapid growth, that for economic

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conditions it was decided to prepare an entirely new plan. The six taxing bodies of all local governments then retained Harland Bartholomew and Associates, of St. Louis, Missouri, to collect data, and prepare plats, tables, and all other details connected with a comprehensive City and Community Plan. The six taxing agencies who were financing the plan each appointed a representative, and these six in turn selected five other members, not local officials, who would be representatives of various other phases of city life.

We then organized what we called the Decatur and Regional Planning Committee, which, during the period of study, was unofficial in scope. The writer was elected chairman of this group and the group met monthly for two years. During this two-year period, the planning engineer and his consultants discussed at each meeting the progress they were making in the various phases of preparing the plan, and since this committee included all those whose duty it would be to carry out the recommendations of the plan, it was possible to provide not only a plan that was ideal but also one that would be practical to carry out.

This committee then began to realize that if all of the readjustments and the new improvements were made in accordance with this comprehensive plan, adequacy, efficiency and economics would result. I think the best feature in the preparation of the plan has been the fact that it was paid for by the public and their duly elected and authorized officials. The formation of this plan required two years work by the resident consulting engineers, and at least one official of the consulting firm spent one day a month in the community for every regular and special meeting of the planning committee.

The planning engineer completed his work in January of 1939, and, as a result, prepared nine subdivisions of the comprehensive plan. These subdivisions are as follows: "Existing and Probable Future Population;" "Major Streets;" "Transportation;" "Local Transit;" "Zoning;" "Recreation;" "Housing;" "Public Buildings and the City's Appearance;" "Administration of the Plan."

During the progress of the preparation of the plan, the planning committee appointed sub-committees, and, as each subdivision of the plan was completed, it was referred to this sub-committee for special study. Following the sub-committee's consideration of the various phases of the plan, the sub-committee would report to the planning committee as a whole, and after due consideration and possible changes and revisions, the committee would approve the subdivision of the plan. From this it is evident that all members of the planning com-

mittee were in a position to be thoroughly conversant with the work of the consultants.

At the time this is being written, Decatur has grown to a city of approximately 65 000 and the population of the county has grown to approximately 85 000. During the two decades between the preparation of the 1920 plan and the present date many changes in urban life have taken place. For instance, the 1920 plan advised about 70 miles of street car tracks for the city, while today there are no street car tracks and all local transit is handled through busses. The city's largest industry today is the processing of soybeans; in 1920 this industry was unheard of. Many other changes of similar nature have occurred and, no doubt, will occur in the future. However, planning, as such, implies looking ahead, and is the determination of a definite objective and policy. Community planning determines the probable future needs of a municipality and how they may be obtained. The consistent following of a preconceived plan is the only known method whereby a city and community can avoid the many mistakes which have been made in the past.

Our city, the same as any other, is similar to a large factory or industrial corporation, and a city's plan is further complicated by the large number of administrative agencies. However, in the preparation of our plan all of these agencies have joined hands, and it is reasonable to expect that a very large percentage of the recommendations of the plan will be carried out. Following completion of the planning consultant's work in January of 1939, and acting on enabling legislation passed by the Illinois Legislature during the last decade, the mayor and city council appointed an official planning commission. The personnel of the official planning commission is practically the same as that of the unofficial committee which steered the work prior to the consultant's fulfilling of his contract.

The official commission meets once a month, and it is gratifying to note that practically all of the improvements paid for by the public during the past few years have been made in accordance with the present city plan. The county government has realized the necessity for controlling subdivisions which are being platted outside the city limits, and have taken necessary steps to improve the standards of outlying sections in accordance with the plan's recommendations.

There are many valuable results already effective, especially from the original plan, which would not have been available had it not been for the far-sightedness of the citizens who first promoted the plan. To mention a few of these, the manufacturing establishments between

1909 and 1929 increased 5½ times, both as to value of manufactured products and number of persons employed. The average annual wage in 1909 was $530, in 1939 it was more than $1270. Between 1929 and 1935 the decrease in the amount of retail sales in Decatur was far less than in many other cities of similar size.

One of the best results of the early plan was the construction of a large lake, which was formed by building a large impounding dam in the Sangamon River. This is known as Lake Decatur, and is approximately 14 miles long and 1 mile wide. Once Lake Decatur was constructed, it changed the urban life in Decatur and environs greatly. It has established a recreation center for a wide area in central Illinois, because of the fact that when the lake was formed it was the only one of its kind for miles. It has developed high-class residential sites; it has provided an unlimited water supply, which is necessary in attracting worth-while industries to the community; and for many other reasons it is the outstanding civic improvement of this community.

In considering population trends in our county and city, and basing the estimate of the growth on past records plus the records of the state and nation, we anticipate a continuous growth probably until 1965, when it is logical to expect that the population curve will level off. At that time the projected population in the city will be about 95 000, the population of the county will be 105 000, and our plan has been developed keeping these figures in mind. The density of future population, based on these figures, shows that only a few of the neighborhoods will have a density of more than 35 persons per acre. Of course, the areas of the greatest density of population will be located near the center of the business district. The majority of the neighborhoods will have a density of between 30 and 35 persons per acre. The urban area recommended for the ultimate population is approximately 8600 acres, giving an ultimate gross density of slightly less than 11 persons per acre. This development will provide large lots, many open spaces, and considerable school grounds and parks.

In order to serve this ultimate population in the projected area, a comprehensive system of major streets has been planned, keeping in mind the desirability of limiting traffic from minor streets in order to protect and improve the character of abutting residences. As was mentioned previously, the city has had a railroad development which provided radial routes, and the Illinois Division of Highways have very adequately provided through state highways radiating from the center in eight directions and generally paralleling the railroads. These radiating routes have been intersected near the limits of the

present urban development by a complete system of belt line highways. However, the increase of automobile traffic has been so extensive and so rapid, that we now realize that the widths, horizontal and vertical alignments, and other features of existing routes are not adequate. Our plan, therefore, provides for an additional belt line so that much more through traffic may be by-passed. Our plan also contemplates several additional grade separations in the city. At present there are approximately 10 grade crossing eliminations in the urban area, all located on major streets, and with the addition of those recommended by our plan, it will be possible to enter and leave Decatur on any through street without encountering railroad grade crossings. In developing the system of county highways, the plan is to provide a continuous system of lake shore drives which will serve both a scenic and utilitarian purpose. Outside of the immediate urban area, the county has provided two continuous belt lines and many other land use routes. At present, every resident on the county highway system is on an all-weather improved highway and all proposed county routes are in accordance with this community plan. These routes adequately care for the traffic moving through the state and also provide connections with several small towns.

Our plan has studied rather thoroughly the parking problem, especially within and near the central business district, and it has been definitely arranged to give parking meters a trial in the near future.

The present planning act in Illinois provides authority for the local planning commission to approve of all new subdivision plats within corporate limits and within 1½ miles thereof. The City of Decatur, as previously mentioned, has appointed an official planning commission, and they require that all plats within the described area be passed upon by the commission before they can be officially recorded. It is recommended that consideration be given to securing an amendment to the present State Planning Act which would enable both the city and county to require the developer of any new subdivision to install the necessary public improvements, such as paving, sewers, water, etc., before the plat can be recorded and lots sold therefrom. Such a provision is now found in the planning enabling acts of several of the states.

Considerable study has been given to the relation of the railroads to the city plan. Decatur and Macon County have five railroads, which provide convenient access to other portions of the country. The Wabash Railroad Company maintains division offices and shops in

Decatur, and is one of the large industries in the community. This is also true of the Illinois Terminal Railroad. The plan provides for certain short sections of the railroads to be re-located, but in general the railroad facilities are adequate. The need of grade crossing elimination, which was previously referred to in this discussion, is, of course, very important from the railroads' point of view, and in this connection ties in with the major street improvements.

The need of local transit is a very important one in this community and the studies have shown that more than 12 000 passengers per day are carried on the local transit system. The city plan made some recommendations as to location of the transit routes, but does not attempt to be concerned with the operating details. The plan provides for locating transit facilities that will serve the ultimate population together with the recommended urban areas. Duplication of service is omitted and the routing is so recommended that there will be only a short walking distance for a bus route from any part of the city.

One of the major features in any community plan is the need of zoning, and in our Decatur and Regional Planning Group zoning will receive a large part of the attention. We all are familiar with the growth and economic situation in the past as it has been generally unregulated and unrestricted. The modern zoning ordinance should mold the city into a form which is orderly and efficient, whereby the various uses of land and buildings are properly related both to each other and to the future needs of the city. The first zoning ordinance was adopted by the city in April, 1923, and was supplanted by the existing zoning ordinance in July, 1928, so that the citizens have had the advantages and protection of zoning for some years. However, there are several features that indicated the necessity of making certain revisions in the present Decatur zoning ordinance. At present this subject is receiving due consideration by the city council, and a new ordinance has been written and is being studied prior to adoption.

Among the other subjects that were studied and which were involved in the completion of the final report, probably the improvement of park and school recreational facilities was paramount. Of course, schools and parks are essential facilities in city areas, and add to the service for educational and recreational purposes. They offer improved social conditions and protection, increase land values, and create a tendency to encourage the proper maintenance and improvement of surrounding residential property. The plan was developed for a population of the projected size with enough school facilities to adequately serve this ultimate population. The new schools are to

be located in centers of projected new populations, and it was recommended that every school have a play-ground park of proper size. Certain neighborhood parks were recommended, although the City of Decatur at present is very fortunate in having an ideal park system. Many park sites around Lake Decatur have been acquired, and a system of parkways coinciding with the major streets surrounding the urban areas has been recommended.

The matter of housing has been thoroughly gone into, and in order that this important phase of community planning be specifically adhered to, the mayor and city council appointed a housing authority immediately upon completion of our present plan. This housing authority has already prepared, and has submitted for federal consideration, a proposal covering the erection of about 400 low-cost housing units. It is anticipated that action will be taken on this application very soon.

Our city plan has thoroughly considered the desirability of improving the city's appearance. We realize that public buildings should be attractive and arranged in an orderly manner so as to set an example for the citizens. Street trees should be plentiful and well maintained. They are a most effective means of breaking the monotony of the many man-made buildings. Many of our existing public buildings are new and in a very excellent condition, and will continue to serve for many years. This is particularly true of a new million-dollar county building that will be completed in two or three months. The county acquired a full city block, part of which was the site of the old structure, and is erecting the new building in the center of the block. This will leave considerable space around the building for landscaping, etc. In 1935 a new federal building was erected, and this building is adequate to serve a population of approximately 100 000. A move is on foot at present to provide new facilities for the city government, and definite steps are being taken to make this a reality. The plan recommends the grouping of the city and county buildings to develop a civic center. This plan also contemplates a memorial shaft between the two buildings dedicated to the memory of Abraham Lincoln, whose first Illinois home was in Macon County, and who was first mentioned for the presidency in the City of Decatur.

We realize that the foregoing constitutes the master plan for the growth of Decatur and Macon County and is a guide for future development. It is not a rigid plan but one which is flexible, and which can be revised whenever deemed necessary by the planning commission. The commission also realizes that, in order to carry out the plan,

it is necessary to have the citizens conversant with the plan, and able to appreciate the advantages which can be obtained from following the plan. Finally, the plan provides for economic growth, that is, public works will not be undertaken that would be too large for future needs. Also, an economical public development is an inspiration to the expenditure of private capital in various enterprises, and it is logical to expect a consistent planned development both in the expenditure of public funds and private investments.

XIII. COUNTY ZONING AND ROADSIDE IMPROVEMENT
(Synopsis)

Robert Kingery*

County zoning is a more recent application of the regulation of use of lands in Illinois, such authority having been granted to county boards or boards of supervisors, applying to the unincorporated area of counties, in June, 1935, by the State Legislature. In Illinois, since the first municipal zoning statute was enacted in 1919, and amended in 1921, cities and villages had authority to zone municipal territories.

Just as cities have done, the counties of Illinois which have drafted zoning ordinances have divided the area into four main divisions, some of these divisions being further subdivided. They are: (1) industrial, (2) business, (3) residential, and (4) farming.

These divisions are made only after the county has been accurately mapped. The maps for each township of the county should show every industrial building or land use, every business or commercial building, every residence, whether it be a farm or a suburban home, and any special uses of land such as quarries, gravel pits, automobile dumps, and the like, where no buildings are involved. This mapping is done under the direction of a zoning commission created by the county board. After the mapping has been done, the zoning commission is to decide upon the number of districts and their locations, and show the boundaries of such districts on the maps. Then the commission must also prepare the text of an ordinance which prescribes the regulations to govern the several uses permitted in each district.

When the commission has prepared the text of the ordinance and the maps, it is required to hold a public hearing in each township. Then when all of the amendments have been made to the text and to the maps as a result of the hearings, the commission concludes its job by preparing a short report to the county board transmitting the ordinance, including the text and maps with the recommendation that it be adopted. The original survey maps should become a part of the county's official zoning records after the adoption of the ordinance. Then when the ordinance is adopted, a board of appeals is created which holds hearings on any appeal from an application of the ordinance or on any proposed amendment.

Five counties have already adopted zoning ordinances in Illinois. They are: DuPage, Kane, Lake, Winnebago, and Kendall. Two

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counties, Will and Cook, have zoning commissions which are at work on their respective ordinances.

One court decision has been handed down by the Illinois Appellate Court denying the right of an automobile junk yard owner to enlarge his junk yard on to adjacent residential property. The case arose in DuPage County, and was vigorously and successfully handled by the state's attorney.

Among the results of non-regulation of unincorporated area are such roadside uses as automobile junk yards without restriction, highway parking alongside taverns, roller skating rinks, and other such establishments which should provide "off the highway" parking areas; subdivisions platted in marshes where drainage is impossible; outdoor advertising in residential and farming zones; and new buildings so close to the highway right-of-way line as to make highway widening more difficult.

Regulation by reasonable and intelligent county zoning segregates industrial uses of all kinds, including automobile junk yards, into areas where they should do the least damage to property values; allocates business locations at highway intersections in orderly groupings rather than in long ribbons along highways; sets up residential zones in which there is proper space between the buildings, and proper separation of water wells from septic tanks; and generally makes for an orderly growth in the unincorporated area rather than a disorganized growth which brings sharp and unpredictable fluctuations in property values.

The result of county zoning after four years in DuPage County has been a very substantial increase in rural residential buildings, and the values of such rural residential buildings averages higher each year because of the obvious protection which is given. It is expected that similar results will be found in the other counties when the operation of their zoning ordinances has extended over a long enough period to observe such changes.

XIV. SUBGRADE BEHAVIOR

J. W. Poulter*

It has been known for some time that the action of traffic over a pavement may produce a shifting of the materials in the grade immediately adjacent the lower side of the slab, also that this condition with its associated pumping action develops more rapidly at transverse cracks and joints; but this did not become a serious maintenance problem until the last few years with the increased amount of high-speed heavy truck traffic.

During the past summer, the writer coöperated with the Bureau of Maintenance and the Bureau of Materials of the Illinois Division of Highways in carrying out projects in both the Springfield and Elgin districts in which a series of treatments were tried.

While the purpose of this work was to check materials and method of maintenance procedure, it seemed best for obvious reasons to also consider somewhat in detail some of the fundamental natural principles involved in the action of traffic on a pavement and its effect on the grade.

There is a deflection of a pavement under a loaded wheel and a movement of this deflection along with the movement of the wheel. Also there is an interruption or magnification of this deflection at the joints and transverse cracks with its particular effect on the subgrade.

Consider first the action at a transverse joint, assuming a one-inch opening, no load transfer, and no water present. For well known reasons the point of greatest deflection in this case will be at the slab ends, also the end of the first slab will begin to settle with the wheel some distance back while the end of the second slab will not be effected until the wheel passes over the joint. Assume further that settlement at the end of the first slab begins when the wheel is 30 in. back and that the total deflection of either slab at the end is $\frac{1}{8}$ in.

From this it can be seen that the time required for the end of the first slab to settle this $\frac{1}{8}$ in. is the time required for the wheel to roll 30 in., while the time required for the end of the second slab to settle the $\frac{1}{8}$ in. is the time required for the wheel to roll only 1 in., or the end of the second slab settles the $\frac{1}{8}$ in. in $\frac{1}{30}$ of the time of the first. Naturally, this difference in rate of deflection with its associated much larger difference in impact causes a very different effect on the grade under adjacent ends of adjoining pavement slabs.

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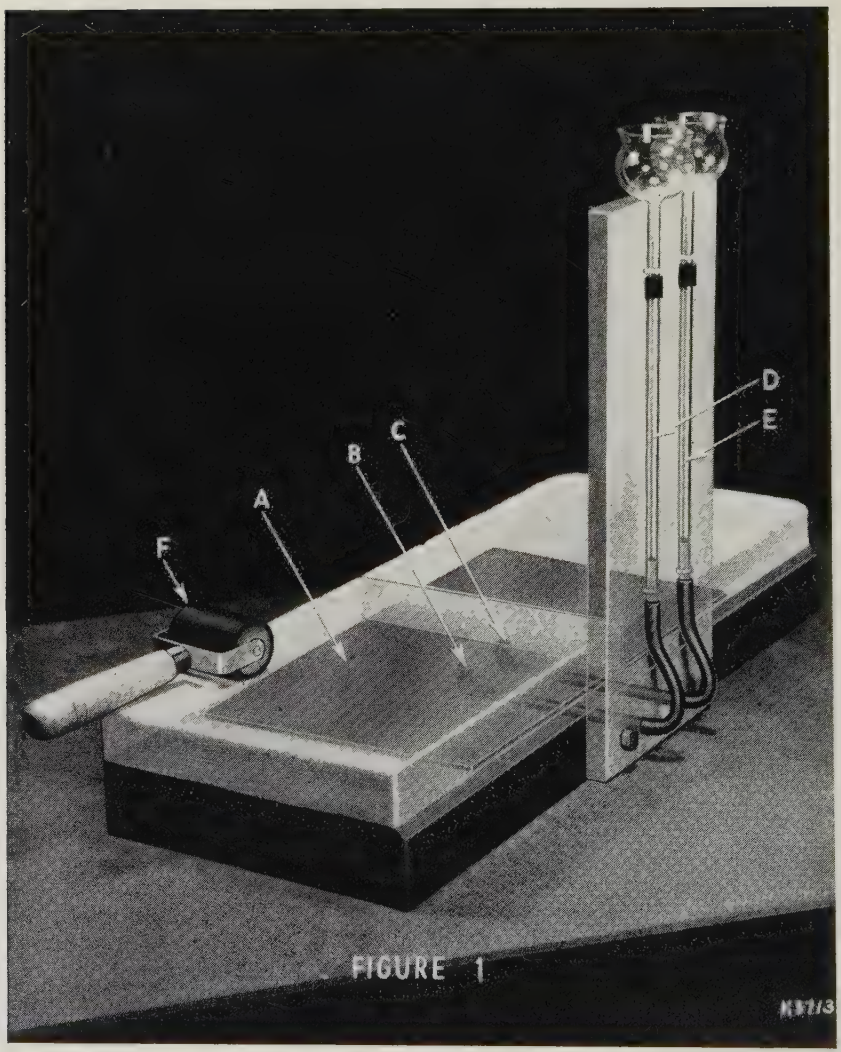

Fig. 1

There are many types of soils where this in itself will cause a shifting of the subgrade material from under the receiving or faster moving end of slab, resulting in the offset or faulted joint condition somewhat common in several states.

With water present, the comparatively slow deflection of the end of the slab as the wheel approaches the joint allows the water to be

forced ahead under the end of the next slab. In passing over the joint, the end of the second slab is forced down, but the water cannot get back under the first slab as the wheel is at the moment resting on it also. Therefore the water must either come up through the joint or be forced latterly to the edge of the slab. Because of the rate at which this end of the slab is deflected, this water travels at a comparatively high speed carrying some subgrade material with it. This is often referred to as "pumping" and is evidenced by the characteristic slab discoloration or by an opening formed in the shoulder along the edge of the slab.

A plaster model shown in Fig. 1 was made up to study and illustrate this difference in water movement at adjacent ends of adjoining slabs as a loaded wheel approaches and passes over a joint or crack. In this model a rubber bag *A* was placed under the ends of plaster sections, which were made up to represent a pavement slab at a joint. Connecting into this rubber bag *A*, at *B* and *C*, are two tubes leading to two thistle tubes *D* and *E* supported at the side as shown. The bag *A* was filled with water until there was about half-an-inch showing in the thistle tubes. As the rubber faced roller *F*, with some pressure exerted, is caused to approach the joint the water in both tubes rises slowly and to about the same level. This continues until the roller passes over the joint, when there is a rapid rise in the water in the tube which is connected to the bag *A* under the slab onto which the roller has just moved. If the roller is moved in the opposite direction, the rapid rise is in the other tube. This not only illustrates the difference in the rate of movement of water under adjacent ends of adjoining slabs under the action of traffic, but that this difference is dependent on the direction of traffic.

From this it would be expected that a greater part of the subgrade material being carried by the water would come from under the receiving end of the slab or the end just past the joint or crack. This is not only evidenced by the settlement of that part of the pavement, but much earlier by openings forming in the shoulder along the edge of the slab, which are for the most part past the joint or crack in the direction of traffic.

In the early stages these openings appear only as slightly widened cracks or several small holes no larger than a lead pencil, but as pumping progresses they may become four to six inches wide, go down to below the lower side of the slab and extend from two to four feet from the joint along the edge of the slab. Where shoulders are maintained with gravel or crushed stone, these openings become filled

FIG. 2

with this material, but this is kept washed clean by the pumping action, and, while not so apparent, carries almost as much water under the slab as the open hole or blowout.

Figure 2 shows an opening in the shoulder just past a crack not long after it had formed. This is one of the early indications of pumping but there is no offset or faulting as yet. Figure 3 shows the condition at a certain joint on April 28, 1939. The arrow indicates the direction of traffic. Figure 4 shows this same place on January 4, 1940, or slightly over eight months later. In this time two cracks have formed beyond the joint and show signs of pumping. This is particularly so with the first, as indicated by the blowout about two feet past it, which is in keeping with the theory advanced.

It has also been noted that a pavement may carry traffic for several years before there is any indication of pumping, and further that after pumping does start there seems to be a progressive rate of development. This rate of development seems to depend on several factors, such as pavement conditions, grade conditions as to drainage and types of material, but it depends as much or more on the type of traffic as anything else. It is very noticeable in this connection that there is little or no pumping with pavements carrying only light trucks and passenger car traffic.

This delay and progressive rate of development can be explained by the progressive increase in the rate of washing of a subgrade immediately below a pavement slab, or, going further back, by the

FIG. 3

FIG. 4

progressive increase in the rate of flow of a film or layer of water between the slab and subgrade with the increase in the thickness of the film under the same traffic loading.

Time has not permitted the obtaining of definite information which would apply directly to the increase in velocity of a film or thin layer of water under a pavement as it increases in thickness, and no doubt each joint would present a different problem, but there seems to be good evidence that there is a considerable increase in velocity with increase in thickness of film. The erosive power of water or its power to overcome cohesion varies as the square of the velocity of the current. The power to carry sand or other loose materials goes up much more rapidly. One investigator has reported that this carrying power varies as to the sixth power of the velocity.

From this it can be seen that only a small increase in the film thickness and the corresponding increase in velocity of the movement of water under a pavement slab due to the action of traffic will cause a large increase in the force tending to carry the subgrade material away. This explains why the rate of disintegration increases very rapidly as pumping progresses.

It can be concluded that many pavement failures are the results of the washing action of water under a slab due to the action of traffic over it. No doubt much can be done at the time of construction of a new pavement to prevent this but there is the question as to what extent this can be done and yet remain within the realm of economic possibility. Very likely a certain amount must be left for maintenance, but the development of some method for correcting the effect of this washing action is needed, which naturally is the case with pavement already down.

XV. CEMENT BOUND MACADAM AND PAVEMENT RESURFACING

Devereaux H. Murphy*

Springfield, along with other cities in the state, finds itself in the position of having a large unemployment load and a system of old brick streets badly in need of reconstruction or rehabilitation. Accordingly, the problem which confronts these cities is to take care of the unemployment load and at the same time obtain worth-while public improvements.

We have used two types of construction which solve this problem, namely, cement-bound macadam and brick relay. The former has been used on streets originally paved with two-course brick, and on streets where the base under one-course brick had failed.

Definition.—Cement-bound macadam is constructed by placing a layer of broken salvaged brick supplemented by a top layer of crushed stone or gravel, the entire mass being bound together by portland cement grout.

Construction Procedure.—The method of procedure is substantially as follows: The brick are removed, cleaned and piled along the curb. It is vital that each brick be thoroughly cleaned of all dirt and foreign substances which would prevent an intimate bond between the broken bricks and the cement grout. The brick are then broken by hand into sizes ranging from ¾ in. to 2 in. and deposited into neat piles alongside of the work. The final screening of the brick is done with forks as they are loaded in the wheelbarrows before being deposited on the subgrade. The existing sand cushion is then removed, screened, and stock piled. This salvaged sand is generally used for sand cushion on brick relay work. Part or all of the existing base is then removed if necessary to secure the proper grade and crown for the new pavement. In the case of two-course brick pavement with no base the subgrade is shaped and tamped to the desired cross section.

Wood forms are then set for slab widths of from eight to twelve feet. Two-inch lumber is used for these side forms. A continuous wooden strip is attached to the form midway between the upper and lower edges so as to form a longitudinal key when the pavement is placed against the form. The forms are thoroughly cleaned and oiled for each use.

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The crushed brick are then spread on the prepared subgrade between forms, usually to a depth of four or five inches. Upon this course of broken brick a supplemental layer of crushed stone is spread to a depth which will give, after compaction, grouting, and finishing, a pavement of the desired thickness and crown. The aggregate is tamped with a longitudinal straight-edge, and is tamped and checked transversly with a tamping template cut to the crown of the pavement. The pavement is now ready to be grouted.

Grouting.—The grout is proportioned as follows: one bag of cement to 188 pounds of dry sand, plus an amount of mixing water which will produce a grout of workable fluidity. It is important that 100 per cent of the sand pass a No. 8 sieve because it has been found that grout containing coarser sand did not completely fill the voids in the coarse aggregate.

The fluidity of the grout is measured by the time, in seconds, required for a given amount to pass through a ½-in. circular opening at the bottom of a conical receptacle approximately 10½ in. high, 7 in. in diameter at the top, and ½ in. in diameter at the bottom. The grout should flow through this receptacle in about 21 seconds so that it will flow readily into the coarse aggregates with no separation of the ingredients. This requires about 7 gallons of mixing water per bag of cement.

The grout is mixed in steel mortar boxes set on wheels. These boxes have a side gate which is raised to allow the grout to run into a distributing trough having one-inch holes spaced at three-inch centers. The grout flows down through the aggregate and spreads out along the subgrade, its progress on the subgrade being checked by cardboard cylinders which are set in the aggregate at about 8-foot centers. As the grout appears in the cylinders, they are removed and the holes filled with coarse aggregate. The grout distribution proceeds progressively forward from side to side of the pavement, in order to prevent the formation of air or water pockets back of the grouting. When the grouting has been completed the entire mass is compacted with a tamping template four or five inches wide. Tamping proceeds across the pavement parallel to the center line. After the excess water has escaped the tamping is repeated. Surface irregularities of more than ¼ in. measured from a 10-foot straight edge are corrected either by the use of a hand tamper, or by trimming such places with stone rakes, and then recompacting with the longitudinal tamping template. At this stage the coarse aggregate is still showing through the grout. A

grout of the consistency for finishing purposes is then spread over the pavement surface. This grout is vigorously worked into the pavement and finished off with hand floats and straight edges. At the proper time the cement-bound macadam is belted with a burlap bag. After dragging with the burlap, the joints are edged and the pavement broomed. Cement-bound macadam is cured in the same manner as portland cement concrete pavement.

Expansion joints are set every 60 feet at right angles to the center line of the pavement. Contraction joints are set every 20 feet. The expansion joints consist of one-inch pre-molded bituminous filler. They are installed before placing the coarse aggregate on the subgrade, and are set and held firmly in place to prevent any movement during the construction operations.

Contraction joints are formed by placing a ¼ in. x 2 in. iron strip edgeways with the top flush with the finished surface of the pavement. This strip is inserted after the coarse aggregate has been brought to grade, but prior to the grouting operation. It is left in place until the macadam has hardened sufficiently to permit its removal without distorting the groove thus formed. All joints are edged with a tool having a radius of ¼ in. Before the pavement is opened for traffic, all joints are filled with bituminous joint or crack filler.

The appearance of the finished pavement is similar to that of a concrete surface. The riding qualities are very good considering the hand finishing methods. All in all, for a low duty concrete street, cement-bound macadam has proved very successful.

Brick Resurfacing.—On old brick streets having a base in good condition, the bricks have been taken up and relaid. This too, you will notice is a labor-using process. The brick are removed, cleaned and piled along the curbing. The sand cushion is then removed, and screened to be used again. The base is then repaired where necessary and a 1:2 grout levelling course is used to remove irregularities and provide the proper crown. The levelling grout is allowed to cure for 48 hours, a one-inch sand cushion is applied, and the brick is relaid with its best wearing surface up. A 1:2 grout is used for filler, and one-inch bituminous expansion joints are placed every 30 feet. In modernizing and widening some of our streets, a combination of cement-bound macadam and brick relay has been used to good advantage. The existing brick street was relaid, and cement-bound macadam was used for the widening.

XVI. PROBLEMS IN DETERMINING THE LOCATION OF A SUPERHIGHWAY

Harry W. Lochner*

The Board of County Commissioners of Cook County has obligated itself to build immediately, at least one of the superhighways proposed to provide adequate modern entries into the City of Chicago. The one selected is a highway beginning at the central business district of Chicago and extending northwesterly to approximately the city limits.

Studies have therefore been made by the Cook County Highway Department, under the direction of Major Quinlan, County Superintendent of Highways, to determine the most feasible and satisfactory location and type of design for that highway.

Many locations for the northwest superhighway were considered. In general, they fall in three groups, the first lying parallel to and adjacent to the Wisconsin division tracks of the Chicago and North Western Railway, the second parallel to Clybourn Avenue and Elston Avenue, and the third parallel to Clybourn Avenue, the North Shore Channel and Bryn Mawr Avenue. Many alternate sections were considered in this area in an effort to work out a feasible location through this rather heavily developed industrial area.

Aeroplane photographs of the areas traversed by the routes were used in determining the several locations. By means of these maps, together with Sanborn Insurance maps, the necessary information regarding physical obstacles found in each area was readily determined without making field inspection.

So as to locate the least expensive properties, and thereby find a highway location which would be least costly from the right-of-way purchase standpoint, the valuations of the land and buildings in each block were estimated and expressed in an average price per square foot for each block. Maps were prepared showing in red the blocks in which the land and improvements averaged less than $1.50 per sq. ft., in yellow those blocks averaging between $1.50 and $3.00 per sq. ft., and in green those blocks costing from $3.00 per sq. ft. and up. This is one study where it definitely paid to stay in the red in determining the highway location.

Of the several routes studied, three were selected as being most worthy of detailed analysis and investigation. These three included one location parallel to the North Western Railway tracks, a second

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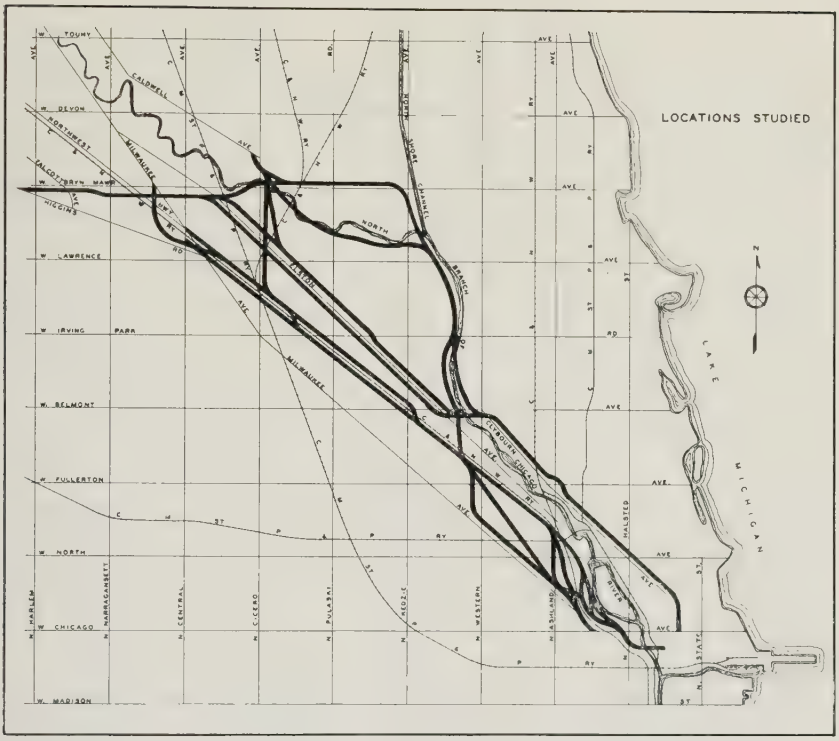

Fig. 1. Routes Studied for Location of a Northwest Superhighway

parallel to Clybourn and Elston Avenue, lying from one-half block to one and one-half blocks away from these streets, and a third parallel to Clybourn Avenue, North Shore Channel and Bryn Mawr Avenue. The northwest terminus of each of these locations was laid out so as to tap the several state highways entering the northwest corner of the city. Cicero Avenue, which taps Skokie Boulevard, is picked up at this location together with Caldwell Avenue. Elston Avenue and Milwaukee Avenue are tapped as they are crossed, likewise the Northwest Highway, with a final connection with Higgins Road, the state road which is now being widened as a parkway type of highway by the State Highway Department. The traffic from each of these highways is picked up before the highways converge and reach points of congestion.

A comparison of these three routes showed that the line parallel to the railroad was the shortest, being 9.5 miles. The Clybourn-Elston route is 9.6 miles in length and the Clybourn-River-Bryn Mawr loca-

tion 11.3 miles in length. The total estimated cost of the route parallel to the railroad would be $17 300 000 for the necessary right of way, and $25 000 000 for construction, making a total estimated cost of $42 300 000. The Clybourn-Elston location would cost about $30 500 000 and the Clybourn-River-Bryn Mawr route about $27 200 000.

In analyzing a highway lying parallel to the railroad embankment, but one type of highway could be built in this location and that would be an elevated structure. It was found that it would be impossible to provide ramps leading to and from the highway where the highway was directly adjacent to the railroad. Access to the ramp would be possible only by passing under a long dark viaduct either under the railroad or under the highway, and then making a very sharp confined turn in the ramp. This turn in the majority of cases would be more than a right angle, which would require vehicles practically to stop. For that reason it was found that the only manner in which a highway might be built parallel to the tracks would be to move the highway about 200 ft. away from the railroad right of way to provide sufficient room between the two embankments to accommodate the ramps and easy connections to the cross streets.

In considering the other two locations a depressed type of highway was considered, being, in general, similar to the type described by the Federal Public Roads Administration in its report to Congress wherein this type of construction is recommended for urban locations.

A count was made of the number of factories which were affected by each of the locations. It was found that the route paralleling the railroad affected 36 such manufacturing plants, the Clybourn-River-Bryn Mawr route 45 plants, and the Clybourn-Elston route 32 plants. The number of employees of these plants, who live in the neighborhood of the plant, whose homes might be dislocated if the plant move were determined, was about 500 if the railroad route were followed, 222 on the Clybourn-River-Bryn Mawr route, and 217 on the Clybourn-Elston route.

From data regarding existing traffic an estimate was made of the traffic usage of such a Northwest Highway if it were provided. It was found from today's traffic figures that about 90 000 vehicles might use such a highway each day. To accommodate that volume of traffic, with a reasonable allowance for future increase, four lanes of pavement would be required in each direction.

The relative density of population in the northwest area of Chicago was determined. The denser areas in which from 8000 to 10 000

persons live per quarter square mile were shown in red on a map and the less densely populated areas in less intense colors (pointing to these areas). Super-imposing the three locations considered on a map, it was evident that the most northerly route, while being the least expensive but the longest, does not adequately serve the Northwest area of Chicago. Of the other two locations the Clybourn-Elston route has a slight advantage over the railroad location from this standpoint. After considering the advantages and disadvantages of the several routes it was found that the location paralleling Clybourn-Elston Avenue appeared the most desirable. Its estimated cost, as I mentioned before, is $30 500 000. That is the location which has been adopted by the county board.

The downtown terminus of such a superhighway should include not only a distribution and collection system for the business district, but should also include articulating connections with the Outer Drive as a means to allow traffic wishing to pass around the Loop to so do without filtering through the present congested surface streets. Many locations to accomplish these purposes were considered. Consideration was given to elevated highways, depressed highways, tunnel pavements, and plaza distributors.

After analyzing each of the possible types of construction, it was found that the most flexible type consisted of connections to four surface streets—Superior, Huron, Erie, and Ontario Streets. Two of these streets would be made one-way east bound and two one-way west bound. Traffic wishing to go to the Loop would use these four streets connecting to the various north and south streets entering the Loop. In addition, tunnel pavement connections would be provided to the Outer Drive in the Oak Street Beach area with a reconstruction of the Outer Drive at that point being studied jointly by engineers of the County and the Park District to provide easy connections without the use of traffic signals. As a future development, the plan calls for a connection to the lower level of Wacker Drive at about Washington Street with the thought that Wacker Drive might be developed south to connect with the West Side Superhighway and the South Side Superhighway.

The tunnel pavements connecting the superhighway with the Outer Drive are being planned as "basement drives." The roof of the tunnel would serve as the pavement of the surface streets. Emergency sidewalks would be provided in the tunnels with frequent stairs leading to the ground level.

The total estimated cost of this superhighway is $40 000 000,

which is being planned to be provided from the county's portion of the gas tax, with no increase of that tax. Under the state laws the county must obtain State Highway Department approval before right of way can be purchased, and before any contracts can be awarded, and through the state we look for guidance in general details and directions to the Federal Public Roads Administration.

This is a picture of the county's gas tax finances during the next 20 years, using a conservative increase of but 3/9ths of that experienced during the past five years. These funds have been tentatively allocated in this fashion:

Deducting the amounts diverted to finance the poor relief bond issues, leaves a balance available for highway construction of about $150 000 000 in the next 20 years' time. Of this amount $40 000 000 might be used to construct this superhighway and, in addition, we have tentatively allocated $40 000 000 during that period of time to the construction of a highway railroad grade separation program on the county's existing system of highways, the majority of which would be of a continuous character. Another $40 000 000 has been allocated for normal surface type of improvements and widenings in the county, and $30 000 000 for the development of a system of Forest Ways which would be extensions of these superhighways in and around the suburbs of Chicago. These Forest Ways are now being planned in conjunction with the Forest Preserve District through the Forest Preserve Advisory Committee.

We find that the development of these superhighway extensions out into the country is very necessary. We find that on Skokie Boulevard, our most noteworthy highway to the north, there is a very high accident rate. The travel there now is 40 to 50 miles an hour. That territory is very rapidly developing. It will not be long before that traffic is choked down to 20 or 25 miles an hour and further improvements will be necessary through this suburban area to carry this volume of traffic.

We have for many years dreamed of these necessary extensive projects and now, by a long range budgeting of our assets, we believe that they can be accomplished with no increase in taxes.

Early this summer (1940), we hope to be in a position to announce our plans for this entire program.

XVII. IN CONCLUSION

C. C. Wiley*

It is probably an anticlimax for me to appear before you after the many good papers of the past two days, but a habit gained over many years is not easily broken. Hence, from force of habit, if nothing more, I address you at this our 27th meeting.

I do not have much to say, but in saying it I may perchance "stick my neck out" and, if so, you are welcome to "take a whack at it," although I warn you that it is well calloused. But I have a theory that by sticking my own neck out, I may induce you to stick yours out and thus give me a chance to take a whack in turn. If you have developed the art of drawing it back quickly enough to avoid the return stroke, well and good, but beware lest you get it permanently in reverse. Consider the tortoise that never gets anywhere unless he sticks his neck out.

Mr. Gries gave us some excellent information and advice concerning roadside planting. But, in so doing, he seemed to frown on the colorful hollyhock because it is not a "native son." I would wager that few of you knew that it was "foreign born" and that still fewer of you cared. In this day of easy universal transportation, it would seem that we might use what we want without regard to its birthplace. The orange is not a native of California.

Mr. Gries also most fittingly emphasized the beauties of Illinois. I have often marvelled that we of Illinois should be taken in by such things as the Wisconsin Dells when our own state is so chock full of places of greater beauty and wonder. It is probably the result of advertising, so what we need is a good, first class press agent.

A queer technical point was presented by Mr. Gries in the proposal that the planting at grade separations should be of such a nature as to accentuate the restricting effect, and thus form a sort of mental bottleneck which would reduce speeds and therefore in turn would promote safety. Evidently this is based on the popular fallacy that reducing speeds always promotes safety. In point of fact, uniform traffic flow is the safest, hence the landscapers would make a contribution to safety by developing a form of planting that would counteract the constricting effect inherent in grade separations.

Our friendly enemy, Hal Foust, told us that we were "lousy" in the matter of public relations and made us like it. Apparently his

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remarks were aimed at "Ernie" Lieberman and his associates, but I think we could read between the lines and thus realize that he included us all, state, counties, townships, cities, and perhaps the University as well.

But having conceded our "lousiness" what are we going to do about it? Just sit and scratch or get busy and "delouse" ourselves? We *must* do something for I say bluntly that the indications are that unless the road administrators of the state, counties, townships, and cities alike take immediate steps to develop a sound, adequate, and coördinated highway program, and then proceed to sell it to the public, we may look for storms in the next and following sessions of the Legislature that will make past experiences merely balmy zephyrs by comparison.

But with respect to Hal's accusation perhaps we may indulge in a little recrimination and tell Hal and his cohorts that they, too, are "lousy." The unmitigated self-conceit of the press as to what constitutes news and how it should be written is astounding, and his theory that desired results are to be attained by eternal "crabbing" is ridiculous. The newspapers, like us, are public servants but they are lying down on the job. If, as he intimated, road work is so full of news and information wanted by the public, why don't they show a bit more industry and initiative in digging it out and using it? They display great energy when chasing down murders and scandals but are downright lazy when it comes to constructive work on public affairs.

Mr. McCurdy gave us some food for thought in his discussion for the need of increased highway revenues. It seemed to me that two points in particular stood out. First, that we should carefully study the actual road needs and, second, that we should budget our present revenues accordingly. Why yell for more money until we are certain that we are spending what we have to the best advantage.

An excellent example of such procedure was given us by Mr. Lochner. In addition to some excellent discussion of the technical feature of locating a superhighway, he gave us to understand that Cook County had figuratively told Chicago and also Illinois to go jump into the lake. By formulating a definite plan and budgeting its resources, Cook County has indicated its ability and intention to start work at once on its share of the much-needed superhighway entries into Chicago. You might say that it has called Chicago's bluff and flung a challenge at the state. Hats off to Cook County.

Little was said in this program about P.W.A., W.P.A., F.A.,

F.A.S.R., and other alphabetical combinations, but along the sidelines was a rumbling that carried an undercurrent of fear that we were becoming so willing to sell our souls for a bit of federal dole that there was a danger of our local units, including the state, becoming mere puppets of the P.R.A. Maybe Uncle Sam should be told to go chase himself, or at least stick to his own knitting and not tangle up ours. Or perhaps we might, instead of mixing federal funds with everything, stick these federal combinations off in one corner by themselves where the P.R.A. could boss them to its heart's content, and thus we would be able to do our own work as we think we should do it.

These same rumblings contained also a bit of feeling that perhaps the state was a bit dictatorial with respect to the counties and cities, but I believe that such a condition is far more imaginary than real. The worst I can say of the Division of Highways is that at times it seems to get its feet tangled up in its own ropes and stumbles about. But it is equally true that the counties and cities are often even more wobbly in their ideas. I think it can be honestly said that when apparent disagreements arise after a little cooling off both parties sit down together and untangle the snarls with the result that the misunderstandings are ironed out to the mutual satisfaction and happiness of both.

You have heard me rave about "standards" on several occasions, and here it goes again. It would seem that this matter of standards is at the root of some of the wrangling just mentioned. But, after all, the trouble is not so much with the standards themselves as with their interpretation. Bad interpretation may turn a good standard into an arbitrary edict.

I did not hear the discussion of secondary road standards so I may be "talking out of turn" but this topic was the direct result of some of this interpretation of standards and perhaps to some extent of deficient standards. There is no use beating about the bush, for one such argument developed right here in Champaign County so we will make this county the "goat."

A little less than 20 years ago Champaign County started the construction of a county system of roads. It took the state practice of the time as its guide and in some respects did a better job than the state. For good and sufficient reasons it accepted the normal 66-ft. right of way, adopted a graded width of 30 ft., and chose a 9-ft. concrete surface which could be widened to 18 ft. for two lanes. The more important and heavily traveled part of the system has been so built and some widening has been done.

Fifteen years of experience have shown that such roads are satisfactory to the people, that they are adequate for the purpose, and that the construction and maintenance costs have been reasonable. Or, at least, they were reasonable until all sorts of fancy gadgets were added to the pavements.

Is it then surprising that Champaign County raised a howl when it was told that to extend these concrete roads into the outlying parts of the county it must now have 80 ft. or so of right of way, wide shoulders, and slabs 20 to 22 ft. wide loaded full of all the gimcracks that the P.R.A. or pestiferous salesmen could invent? In other words, Champaign County was just so "confounded dumb" that it couldn't see why it should be compelled to build to the standards of a heavy duty state trunk highway on the outer ends of a county system that was adequate and satisfactory with a less costly type on the busy ends.

What then was the cause of the argument? It seems that the state has a series of standards for geometric design and also a series of standards for surfaces of different capacities. But in interpreting these standards it seems to have been ruled that they must go "class and class." In other words, it is a violation of standards to put a class B surface on a class E alignment or a class D surface on a class A alignment. The very fact that there are two series indicates that they might be suitably combined to meet conditions, else only a single series covering both geometric design and surface would have been sufficient.

Another phase of the matter seems to be this: There appear to be a number of standards for "traffic bound" and "stabilized" roads and some 57 varieties of "black top" but when it comes to brick or concrete there is only 1, or possibly 2. It is a good deal like telling a railroad that it cannot use steel rails unless they weigh 130 pounds, are set on creosoted white oak ties and fastened down with screw spikes, whereas we know the railroads use lighter tracks of steel rails. A few years ago Mr. Sheets promulgated a rational method of designing concrete pavement in accordance with traffic requirements. Why don't we get busy and do so instead of running around saying that concrete roads on county systems are "uneconomical." Make them economical if the people want them.

There is a lot of unmitigated "hooey" going around in the guise of economics. Many of the statements and conclusions are downright ludicrous. A favorite stunt is to take data from one set of conditions and use them in an entirely different case. I once saw it "proved" that a certain road in Iowa was uneconomical on the basis of data

obtained on the Boston Post Road. If we want to know the economics of concrete roads in Champaign County we should go to the records of Champaign County, not Westchester County, or Germany, or even the state highways of Illinois. Economics of highways is the relation of cost to value, and not a flock of highbrow bookkeeping.

We hear a lot about our "investment" in highways. Highway building is not an investment in any sense of the word. It is merely the purchase of an expendable necessity. We build roads to meet our transportation needs and when they wear out or become unsatisfactory we throw them away and buy new ones to meet our new needs. They are expendable commodities because their life is short as compared with our national life.

But calling them "investments" is dear to the hearts of our pseudo-economists because it gives them a chance to figure compound interest. They even go so far as to say that a road improvement is not justifiable unless it pays its way in tax returns. What asininity! They either wilfully or ignorantly overlook three fundamental factors:

First, roads cannot be considered individually but only in connection with the system as a whole, as has been so clearly brought out by Mr. Glover in connection with the Brashear case. Second, that the financial returns should be based on the savings to the people, not on the tax receipts. And, third, that there is a vast return in intangible social benefits, which cannot be put into dollars, but which probably more than justify our roads whether or not they save one dime in transportation costs, or bring in one cent of revenue.

Amongst the intangible factors is one that we are very prone to neglect. This is the wish of the people in accordance with their likes and dislikes and their feelings of pride and satisfaction. Complaint has been made that the people of Illinois have sold their souls to the Cement Trust and want nothing but concrete. But, beginning on sound economics, the people of this state have grown up to expect a concrete pavement on a state highway. We may argue until we are blue in the face that they are not economical—our figures to prove this are often wrong—but the people expect them just the same and hence are entitled to them. It is our job to build them so that the people get their money's worth in service, satisfaction and pride. This will be more easily accomplished when we learn to design roads in accordance with traffic needs instead of on arbitrary standards. If we believe that some road does not justify a concrete surface then we should take it off of the state system. This will satisfy both the people and our economics. The people of this state are proud of the uniform

character of its state highways, and freely indulge in "wisecracks" about the heterogeneous conglomeration of mixed breeds to be found in other states.

A shirt and pair of shorts will hide a man's nakedness and be low in cost but we hardly expect him to wear them to the office. Overalls might be somewhat better, but still would be frowned upon. So the "junior" or the "chief" alike conforms to at least the minimum standards of office propriety and wears a suit of clothes. But no one goes about proving to him that he shouldn't wear a $50 suit when a $25 suit will cost less and wear almost as long. Nor, if he graduates out of the $25 class, is he told that he must wear a dress suit complete with white tie, diamond studs, spats, and top hat. In fact if he came to the office in that fashion, he would be laughed at.

But what about the roads? Some county roads wear black tops. They serve the purpose, look well, are economical, the people like them, and approval can be obtained for putting them on almost any old kind of a base or graded way. Another county prefers concrete but is told that it will be approved only when provided with boulevard rights of way, heavy duty slabs, and all the accessories in the form of mesh and dowels and patent joints and "what have you," an ensemble as uneconomical and as out of place as a dress suit in the office. Now "laugh that off."

Take the automobile. People buy what they want or rather what the salesman argues them into buying. Dealers do not go out and try to sell cars with a lot of half-baked ideas on economics to prove that their prospects should buy flivvers instead of Packards. If they did they would probably be impolitely told to go somewhere, and the name of the place would not be spelled with six letters.

No wonder our roads lag behind our cars. It is largely the result of rotten salesmanship. If a man thinks he should have a Chevrolet, a dealer tries to sell him a Buick, not a motorcycle. "Sell a used car if you cannot sell a new one, but if you sell a new car, make it a deluxe model." We ought to sell roads the same way, but we don't.

But, going back to the state-county wrangle, I wonder if there is any truth in the accusations that the state frowns on county roads of concrete because under the present law it must maintain them, or that the county wants them because the state must take care of them? If so, for goodness sake, change the law. That provision was put in the law at a critical time purely as propaganda and for sales purposes. If it has outlived its usefulness, get rid of it.

We are cursed by a multiplicity of highway designations that bear

no relation to our administrative setup. State highways by law include practically every cowpath that the state spends a dime on. The counties still grow gray over the remnants of the antedeluvian "state-aid" system, and this new-fangled item of "federal-aid secondary roads" insisted upon by the P.R.A. The townships still live more or less in peace but the cities are getting enmeshed in state route streets, arterial streets, and the like.

We might well kick this whole mess into oblivion and set up a simple classification, based on our own administrative setup of state, counties, townships, and cities. The state system should include only roads bearing state or U.S. numbers, and should be under the direct control of the state. The county system should include the secondary roads on a system patterned after the old state-aid plan. The townships should still control the local roads, while the city streets should still be city streets. Whether these various things are built F.A., S.B.I., C.B.I., 15d, M.F.T., F.A.S.R., or otherwise is purely a matter for office records.

I can't resist saying a few words about pavement widths on trunk highways through cities and villages. Traffic behaves differently in town than in the country. There is usually need for parking, there are frequent intersections where vehicles turn in and out, speeds are lower and vary over a wide range, and there is more traffic. Consequently, two lanes are never sufficient. There should be at least three running lanes with parking lanes in addition. This calls for a minimum width of about 44 ft. between curbs, and I really mean curbs. Such a street, with 3 running lanes, will carry up to 10 000 vehicles per day without undue congestion, while with only 2 running lanes, trouble develops with 3000 vehicles per day.

A favorite blunder is to build country roads through town. The instant a trunk route meets city conditions it should change to a city type having definite curbs of adequate height and with width enough between them to accommodate both running and parked traffic. Sidewalks should be provided and definite turnouts to roadside properties should be made. It is unsightly and hazardous to leave long stretches of flat gutter where cars may enter and leave at all kinds of angles and speeds. In other words, the city street should extend into the country, not the country road into the town.

At a recent meeting of the Institute of Traffic Engineers, this "twilight zone" or "no man's land" at the edge of cities that blossoms out with hot dog stands and the like was discussed. It was pointed out that almost invariably these were accident-prone areas, largely be-

cause traffic can enter or leave the pavement at any place and at any angle, but we do nothing about it but bemoan the accidents, and blame everyone but ourselves. Maxwell Halsey suggested that guard fences be erected with limited openings for entrances but, in my humble opinion, a city type of pavement with adequate width and full-height curbs is safer, better looking, and ultimately is cheaper. And in providing turnouts, do not make them too wide, and, above all, don't just chop the curb down. Notched curbs for driveway turnouts went out of date along with the horse and buggy and the stone curb.

What about C.B.M., cement-bound macadam, that half-breed or half-wit concrete. Isn't it rather curious that you counties or cities can get approval of C.B.M. but cannot get approval of a well-designed concrete slab of thinner section, adapted to your traffic, free from expensive accessories, made of properly-proportioned concrete with good aggregates, and which would be smoother, stronger, and cheaper? Or that you can't get approval for using the same aggregates as permitted in C.B.M. in a normally-designed slab where they are thoroughly mixed together and you know that the cement is properly in place?

Another phase of this highway problem to which we need to give more attention is that of traffic. I do not mean just setting up signs and signals or counting vehicles, or reporting accidents. I mean in building our roads for traffic service. We are still building inconveniences and even hazards into our roads and streets because we do not give proper attention in advance to traffic. Frankly, the design engineers are either still working in the past, or think it is beneath their dignity to ask the traffic engineer about some of the questions.

Another phase of this traffic problem lies in securing better traffic regulation in our cities through the establishment of proper traffic ordinances, the appointment of traffic engineers and the introduction of enlightened enforcement. The Traffic and Safety section of the Division of Highways has been doing a fine job in getting cities to modernize their traffic ordinances and to adopt some form of a traffic engineering department. May this good work go on.

But in connection with this, I am going to take a whack at you city engineers, for you have certainly "stuck your necks out." You are lying down on your jobs. One of the biggest problems in your cities is that of making proper provision for traffic but you are not doing this, and are still "piddling" around with the routine of paving and the like. Are you letting the lawyers write your traffic ordinances? Are you letting the police department locate loading zones, parking

restrictions, install signals, etc.? Writing a traffic ordinance is at least 75 per cent an engineering job. It is the "specifications" for traffic regulation, and writing specifications is an engineer's job. Signs, signals, marking, and the like are all basicly engineering in character, both in design and supervision. Your big opportunity lies in the traffic field. You can hire good men to do routine work.

It is not the function of the police to do traffic engineering. Their job is to enforce the regulations. With very few exceptions, a police department has neither the proper attitude nor the proper qualifications for traffic engineering work. Consequently, every city should have its traffic engineer. This does not necessarily mean a new man in a new job. Many times the amount of work would not justify this, and many times the city does not have the additional funds. But the engineering department should be charged with handling the traffic engineering work, and you engineers should be exceedingly jealous of permitting a non-engineer to do it. But traffic engineering is peculiar in itself. It requires an attitude of mind and a technical knowledge different from ordinary street engineering. If you are charged with traffic engineering duties and recognize your deficiencies, you should seize every opportunity to promote your proficiency.

Speaking of the police, our city police departments also need to be modernized. A traffic squad, even if only one man, is needed in every city. This squad should be composed of men with an aptitude for traffic work, and then trained in the details, including enforcement of the regulations, and the investigation of accidents. If the police department attends to this job properly, it will have all it can do and will stay in its proper sphere.

But I must add one thing to this subject of city traffic work. The biggest handicap is the lack of funds. The limit on the general municipal tax rate and the restrictions on the uses of other funds makes it well nigh impossible in most of our cities for the establishment and maintenance of adequate traffic engineering and traffic enforcement departments. We who are presumed leaders in highway matters would do well to give some consideration to this matter and promote legislation that will make it possible for our cities, great and small, to keep pace with the growing needs of traffic.

I could go on indefinitely as I am full of the subject, but I suspect that you are growing tired of my raving, so our Highway Conference of 1940 draws to a close. During the 26 years since it started, it has been an inspiration to me. I have learned and unlearned many things. I have delighted in the friendships and contacts with you men on the

firing line of highway development. I have been proud of the little I could do to promote it, and I can assure you that the University has taken great satisfaction in being of some assistance. To those who are here for the first time, I bid you welcome and hope you will come again. To those who have been here before and to the "old timers," I hope you feel that this meeting has sustained the traditions of the past, and I am most grateful to you for being here again. To the speakers who have so ably presented our topics, I present our hearty thanks and appreciation. And to all of you, on behalf of myself and the University, I most sincerely wish you a year filled with joy, satisfaction, success, and hard work. And so I say, "so long" hoping to see you all here for the 28th Conference on about March 5, 1941.

FROM THE TRANSACTIONS OF THE ELECTROCHEMICAL SOCIETY, Volume LXXVII, 1940, being the Transactions of the Seventy-Seventh General Meeting, at Wernersville, Pa., April 25, 26 and 27, 1940.

ELECTRO-ORGANIC CHEMICAL PREPARATIONS. II.[1]

By Sherlock Swann, Jr.[2]

Abstract.

This review is an extension of an earlier list[3] of electro-organic syntheses which should be of value as methods of preparation to include literature published before January, 1940. For the sake of clarity the subjects in this paper have been numbered exactly as in the previous one. A letter has been appended to the numbers of tables introducing new subject matter except where it occurs at the end of the paper.

Most of the literature in this paper before 1936 consists of incidental electrochemical preparations found in the experimental sections of organic chemical papers. This literature was not available when the last survey was written.

A list of errata and explanatory notes referring to the 1936 survey will be found at the end of this paper.

The results of the latest search are classified in the following tables:

Part I.

coupling.

Table I.

No new data since last publication.[3]

[1] Published by permission of the Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois. Manuscript received December 15, 1939.

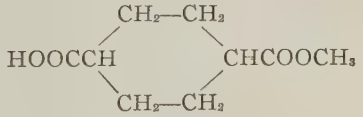
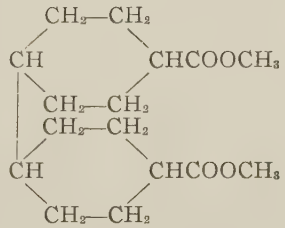
[2] Research Associate Professor of Chemical Engineering, University of Illinois.

[3] Trans. Electrochem. Soc., **69**, 287 (1936).

Table II.

Diesters from Alkali Salts of Acid Esters of Dibasic Acids.

$$2ROOC(CH_2)_nCOOM + 2OH^- + 2F \longrightarrow \begin{matrix}(CH_2)_nCOOR\\ |\\ (CH_2)_nCOOR\end{matrix} \text{ (Anode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
Monoethyl suberate, $HOOC(CH_2)_6COOC_2H_5$	Diethyldodecane-1, 12-dicarboxylate, $\begin{matrix}(CH_2)_6COOC_2H_5\\ |\\ (CH_2)_6COOC_2H_5\end{matrix}$	44	Fairweather[4]
Monoethyl azelate, $HOOC(CH_2)_7COOC_2H_5$	Diethyl tetradecane-1, 14-dicarboxylate, $\begin{matrix}(CH_2)_7COOC_2H_5\\ |\\ (CH_2)_7COOC_2H_5\end{matrix}$	45	Bennett and Gudgeon[5]
Monomethyl-trans-hexahydrophthalate, 	Dimethyl bicyclohexyl-4, 4′-dicarboxylate, 	32.5	Fichter and Holbro[6]

[4] Proc. Roy. Soc., Edinburgh, **46**, 73 (1926).
[5] J. Chem. Soc., 1679 (1938).
[6] Helv. Chim. Acta, **21**, 142 (1938).

TABLE IIa.

Diacetals from Alkali Salts of Acetalic Acids.

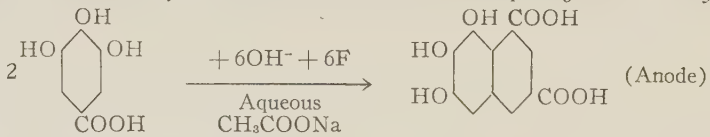
$$2(RO)_2CH(CH_2)_nCOOM + 2OH^- + 2F \longrightarrow (RO)_2CH(CH_2)_n(CH_2)_nCH(OR)_2 \text{ (Anode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
Malonaldehydic acid diethylacetal, $(C_2H_5O)_2CHCH_2COOH$	Succinaldehyde tetraethylacetal, $(C_2H_5O)_2CH(CH_2)_2CH(OC_2H_5)_2$	67	Sugasawa[7]
8-Formylpelargonic acid dimethylacetal, $(CH_3O)_2CH(CH_2)_8COOH$	1, 16-Hexadecanedial tetramethyldiacetal, $(CH_3O)_2CH(CH_2)_{16}CH(OCH_3)_2$	50	Stoll and Rouvé[8]

PART II.

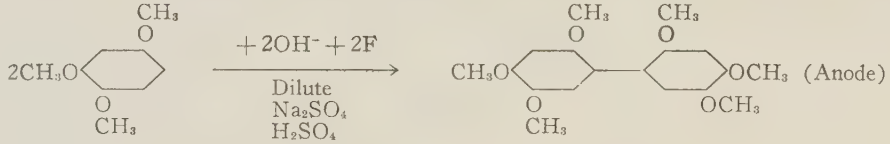
ELECTROLYTIC OXIDATIONS.

Electrolytic Oxidation of Gallic Acid to Sodium Purpurogallincarboxylate.



Sodium purpurogallincarboxylate has been prepared by A. G. Perkin and F. M. Perkin[9] from gallic acid by electrolytic oxidation in 35-40% yields. The structure was established later by Willstätter and Heiss.[9a]

Oxidation of Hydroxyquinol Trimethyl Ether to 2, 4, 5, 2', 4', 5'-Hexamethoxybiphenyl.



Erdtman[10] has carried out this oxidation electrolytically in 85% yield.

[7] J. Pharm. Soc. Japan, No. 545,551 (1927).
[8] Helv. Chim. Acta, **20**, 529 (1937).
[9] J. Chem. Soc., **93**, 1187 (1908).
[9a] Ann., **433**, 17 (1923).
[10] Proc. Roy. Soc. (London), **A143**, 216 (1934).

TABLE IIa.

Coupling of Anions of Methane Polycarboxylic Acid Esters to Form Ethane Polycarboxylic Acid Esters.

$$2Na.CR_3 \xrightarrow[\substack{H_2O \\ C_2H_5OH \\ CH_3COCH_3}]{+2F} R_3C.CR_3 \text{ (Anode)}$$

$R = COOC_2H_5$ or CN

Starting Material	Product	Yield % by Wt.	Investigators
Sodium diethylcyanomalonate, $NaC(COOC_2H_5)_2$ CN	Dicyanobidiethylmalonate, $(COOC_2H_5)_2$ CCN CCN $(COOC_2H_5)_2$	21	Ulpiani and Rodano[11]
Sodium triethylmethane-tricarboxylate, $NaC(COOC_2H_5)_3$	Hexaethyl ethanehexacarboxylate, $C(COOC_2H_5)_3$ $C(COOC_2H_5)_3$	50	Adickes, Brunnert and Lücker[12]

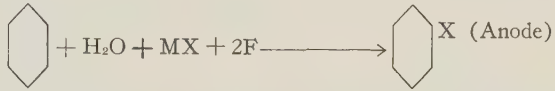
[11] Rend. accad. Lincei, [5], **14**, I, 112 (1905).
[12] J. prakt. Chem., **130**, 168 (1931).

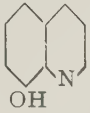
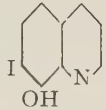
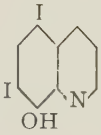
Part III.

REACTIONS WITH ELECTROLYTIC HALOGENS.

Table VIIa.

Electrochemical Halogenation of Aromatic Compounds.



Starting Material	Product	Yield % by Wt.	Investigators
Hydrocinnamic acid, $C_6H_5CH_2CH_2COOH$	*m*-Chlorohydro cinnamic acid, *m*-$ClC_6H_4CH_2CH_2COOH$	99	Mühlhofer[13]
8-Quinolinol, 	7-Iodo-8-quinolinol, 	68	Brown and Berkowitz[14]
Same	5, 7-Diiodo-quinolinol, 	8	Brown and Berkowitz[14]

[13] Dissertation, Univ. of Munich (1905).
[14] Trans. Electrochem. Soc., **75**, 385 (1939).

TABLE VIII. *Electrochemical Oxidation of Sugars to Acids.*

$$2RCHO + 2H_2O + 4Br^- + 4F \xrightarrow[KBr\,CaBr_2\,CaCO_3]{} (RCOO)_2M\,(Anode)$$

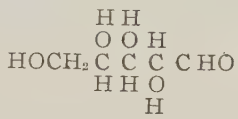
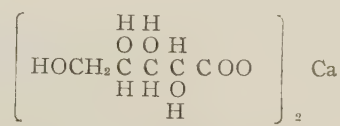
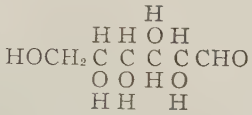
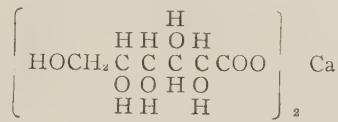
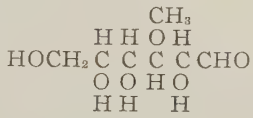
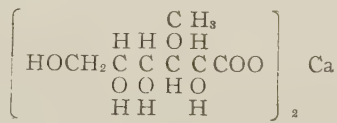
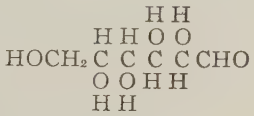
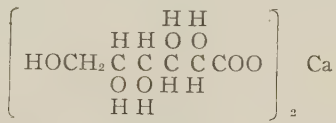
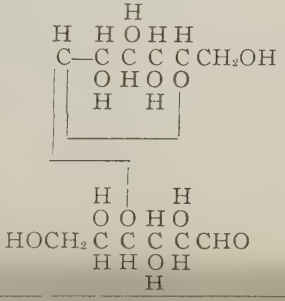
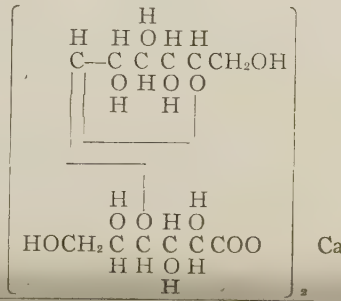
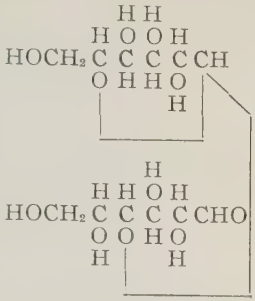
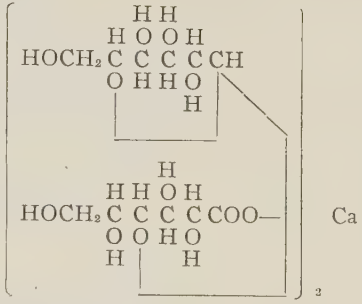
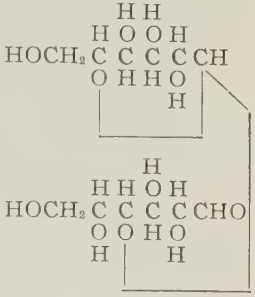
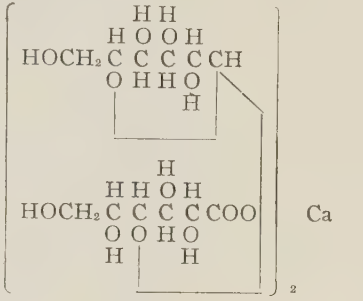
Starting Material	Product	Yield % by Wt.	Investigators
Arabinose, 	Calcium arabonate, 	71.3	Fink and Summers[15]
Glucose, 	Calcium gluconate, 	99.5	Fink and Summers[15]
3-Methyl glucose, 	Calcium 3-methyl gluconate, 	100.0	Schmidt and Simon[16]
d-Mannose, 	Calcium mannonate, 	92.2	Fink and Summers[15]
Maltose, 	Calcium maltobionate, 	74.4	Fink and Summers[15]

TABLE VIII (Continued).

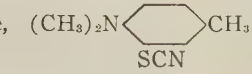
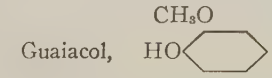
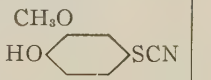
Starting Material	Product	Yield % by Wt.	Investigators
Lactose, 	Calcium lactobionate, 	73.3	Fink and Summers[15]
Lactose, 	Calcium lactobionate Calcium Bromide,  $CaBr_2.6H_2O$	Over 90	Isbell[17]

[15] Trans. Electrochem. Soc., **74**, 625 (1938).
[16] J. prakt. Chem., **152**, 196 (1939).
[17] J. Research Natl. Bur. Standards, **17**, 333 (1936).

TABLE VIIIa.

Electrochemical Thiocyanation of Aromatic Amines and Phenols.

$$R.C_6H_5 + 2SCN^- + 2F \longrightarrow RC_6H_4SCN \text{ (Anode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
N, N-Dimethyl aniline, $(CH_3)_2NC_6H_5$	*p*-Dimethylaminophenyl thiocyanate, *p*-$(CH_3)_2NC_6H_4SCN$	90	Fichter and Schönmann[18]
N, N-Diethylaniline, $(C_2H_5)_2NC_6H_5$	*p*-Dimethylaminophenyl thiocyanate, *p*-$(C_2H_5)_2NC_6H_4SCN$	68.9*	Fichter and Schönmann[18]
N, N-Dimethyl-*p*-toluidine, *p*-$(CH_3)_2NC_6H_4CH_3$	6-Dimethylamino-3-tolyl thiocyanate, 	21	Fichter and Schönmann[18]
Guaiacol, 	4-Hydroxy-3-methoxyphenyl thiocyanate, 	20.7	Fichter and Schönmann[18]

* Weighed as picrate.

[18] Helv. Chim. Acta, **19**, 1411 (1936).

PART IV.

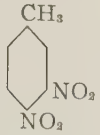
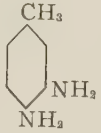
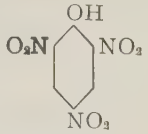
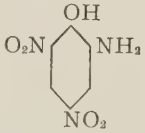
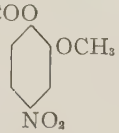
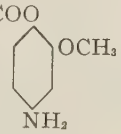
ELECTROLYTIC REDUCTION.

TABLE IX.

Electrolytic Reduction of Nitro Compounds to Amines.

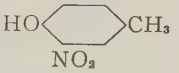
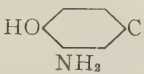
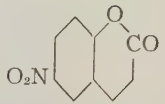
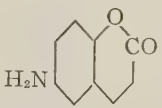
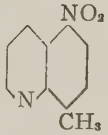
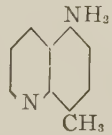
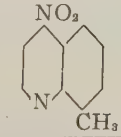
$$RNO_2 + 6H^+ + 6F \xrightarrow[\text{Acid}]{} RNH_2 \text{ (Cathode)}$$

For reduction of *o*- or *p*-Nitrophenols an alkaline catholyte is used.

Starting Material	Product	Yield % by Wt.	Investigators
Nitrobenzene, $C_6H_5NO_2$	Aniline, $C_6H_5NH_2$	96	Reich[19]
3, 4-Dinitrotoluene, 	4-*o*-Tolylenediamine, 	65.5 —69.5	Weyprecht[20]
Picric Acid, 	Picramic Acid, 	85	Huber[21]
4-Nitroacetylguaiacol, 	4-Aminoacetylguaiacol, 	47	Wille[22]

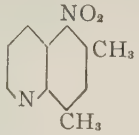
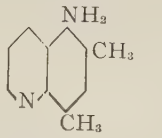
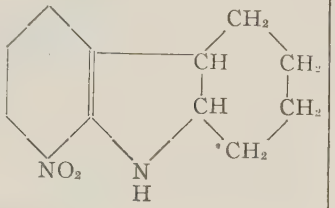
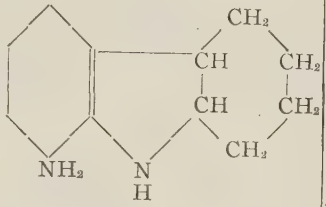
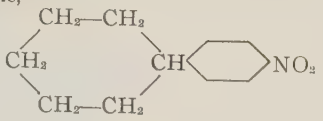
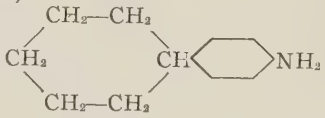
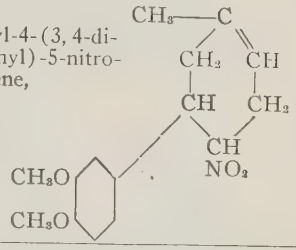
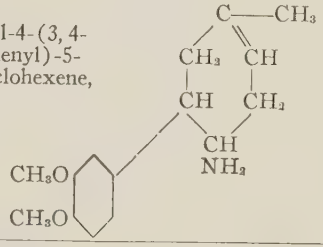
[19] Dissertation, Univ. of Munich (1910).
[20] Dissertation, Univ. of Giessen (1902).
[21] Dissertation, Univ. of Munich (1911).
[22] Dissertation, Univ. of Giessen (1909).

TABLE IX (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
2-Nitro-*p*-cresol, 	2-Amino-*p*-cresol, 	94	Auwers and Eisenlohr[23]
6-Nitrocoumarin, 	6-Aminocoumarin, 	65	Kondo and Ui[26]
Methyl *m*-nitrobenzoate, m-$O_2NC_6H_4COOCH_3$	Methyl *m*-aminobenzoate, m-$H_2NC_6H_4COOCH_3$	87.4	Slotta and Kethur[24]
Ethyl *m*-nitrobenzoate, m-$O_2NC_6H_4COOC_2H_5$	Ethyl *m*-aminobenzoate, m-$H_2NC_6H_4COOC_2H_5$	80	Slotta and Kethur[24]
Methyl *p*-nitrobenzoate, p-$O_2NC_6H_4COOCH_3$	Methyl *p*-aminobenzoate, p-$H_2NC_6H_4COOCH_3$	85	Slotta and Kethur[24]
Ethyl *p*-nitrobenzoate, p-$O_2NC_6H_4COOC_2H_5$	Ethyl *p*-aminobenzoate, p-$H_2NC_6H_4COOC_2H_5$	91	Slotta and Kethur[24]
β-Chloroethyl *p*-nitrobenzoate, p-$O_2NC_6H_4COOCH_2CH_2Cl$	β-Chloroethyl *p*-aminobenzoate, p-$H_2NC_6H_4COOCH_2CH_2Cl$	90	Slotta and Kethur[24]
8-Methyl-5-nitroquinoline, 	5-Amino-8-methylquinoline, 	85	Zöckler[25]
8-Methyl-4-nitroquinoline, 	4-Amino-8-methylquinoline,	90	Zöckler[25]

[23] Ann., **369**, 223 (1909).
[24] Ber., **71**, 335 (1938).
[25] Dissertation, Univ. of Giessen (1904).
[26] J. Pharm. Soc. Japan, No. 498,615 (1923).

TABLE IX (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
6, 8-Dimethyl-5-nitroquinoline, 	5-Amino-6, 8-dimethylquinoline, 	90	Zöckler[25]
5-Nitro-1, 2, 3, 4, 4a, 9a-hexahydrocarbazole, 	5-Amino-1, 2, 3, 4, 4a, 9a-hexahydrocarbazole, 	55	Gurney and Plant[27]
p-Nitrocyclohexylbenzene, 	*p*-Cyclohexylaniline, 	Almost* 100	Neunhoeffer[28]
1, 2-Dimethyl-4-(3, 4-dimethoxyphenyl)-5-nitro-Δ′-cyclohexene, 	1, 2-Dimethyl-4-(3, 4-dimethoxyphenyl)-5-amino-Δ′-cyclohexene, 	94	Sugasawa and Kodama[29]

* Weighed as hydrochloride.

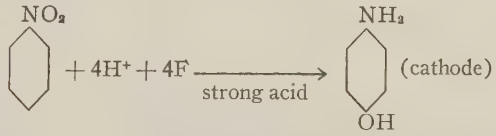
[27] J. Chem. Soc., 1317 (1927).

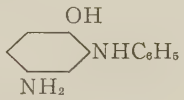
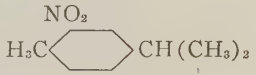
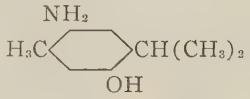
[28] J. prakt. Chem., **133**, 107 (1932).

[29] Ber., **72**, 677 (1939).

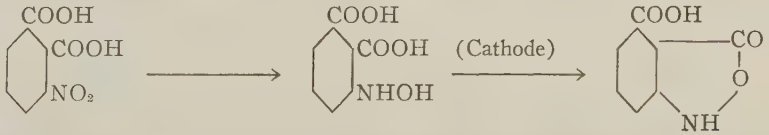
TABLE IXA.

Electrolytic Reduction of Aromatic Nitro Compounds to p-Amido Phenols.



Starting Material	Product	Yield % by Wt.	Investigators
m-Nitrodiphenylamine, m-$O_2NC_6H_4NHC_6H_5$	4-Amino-2-anilinophenol, 	65*	Piccard and Larsen[30]
2-Nitro-*p*-cymene, 	4-Amino-thymol, 	54.5†	Mann, Montonna, and Larian[31]

The Electrolytic Reduction of Aromatic Nitro Compounds to Phenylhydroxylamines.



Gleu and Pfannstiel[32] have shown that 3-nitrophthalic acid may be electrolytically reduced quantitatively to benzisoxazolone-4-carboxylic acid.

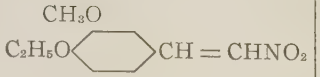
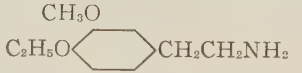
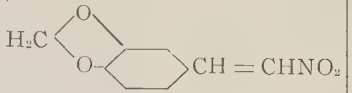
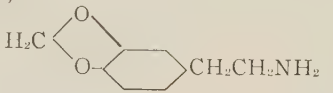
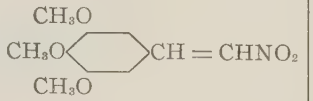
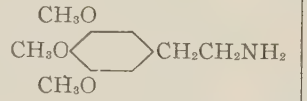
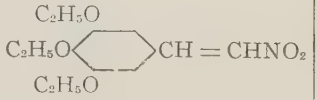
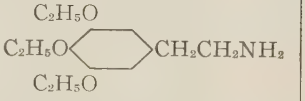
* Weighed as dihydrochloride.
† Weighed as hydrochloride.
[30] J. Am. Chem. Soc., **40**, 1090 (1918).
[31] Trans. Electrochem. Soc., **69**, 367 (1936).
[32] J. prakt. Chem., **146**, 129 (1936).

TABLE X.

Electrolytic Reduction of α, β-Unsaturated Nitro Compounds to Saturated Amines.

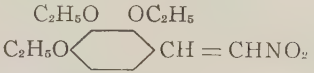
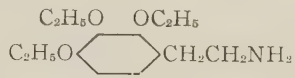
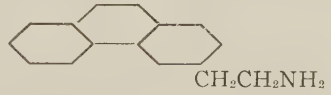
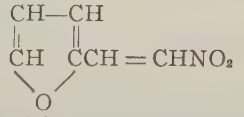
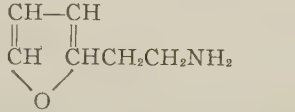
$$RCH=CHNO_2 + 8H^+ + 8F \xrightarrow[H_2SO_4]{} RCH_2CH_2NH_2$$

R = Aromatic group

Starting Material	Product	Yield % by Wt.	Investigators
3-Methoxy-4-ethoxy-β-nitrostyrene, 	3-Methoxy-4-ethoxyphenethylamine, 	69	Kondo, Shinozaki and Ishii[33]
3, 4-Methylenedioxy-β-nitrostyrene, 	Homopiperonylamine, 	79	Tanaka and Midzuno[34]
p-Methoxy-β-nitrostyrene, *p*-$CH_3OC_6H_4CH=CHNO_2$	*p*-Methoxyphenethylamine, *p*-$CH_3OC_6H_4CH_2CH_2NH_2$	61	Kondo and Shinozaki[35]
4-Methoxy-3-benzyloxy-β-nitrostyrene,	4-Methoxy-3-benzyloxyphenethylamine,	60	Robinson and Sugasawa[36]
3, 4, 5-Trimethoxy-β-nitrostyrene, 	Mescaline, 	77.3	Slotta and Szyszka[37]
3, 4, 5-Triethoxy-β-nitrostyrene, 	3, 4, 5-triethoxyphenethylamine, 	77.7	Slotta and Szyszka[37]

[33] J. Pharm. Soc. Japan, **48**, 1166 (1928).
[34] J. Pharm. Soc. Japan, **49**, 255 (1929).
[35] *Ibid.*, **49**, 267 (1929).
[36] J. Chem. Soc., 3169 (1931).
[37] J. prakt. Chem., **137**, 345 (1933).

TABLE X (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
2, 3, 4-Triethoxy-β-nitrostyrene, 	2, 3, 4-Triethoxyphenethylamine, 	78.2	Slotta and Szyszka[37]
m-(2-Nitrovinyl)-methyl benzoate, *m*-$H_3COOCC_6H_4CH=CHNO_2$	*m*-(2-Aminoethyl)-methyl benzoate, *m*-$H_3COOCC_6H_4CH_2CH_2NH_2$	52.2*	Slotta and Kethur[38]
m-(2-Nitrovinyl)-ethyl benzoate, *m*-$H_5C_2OOCC_6H_4CH=CHNO_2$	*m*-(2-Aminoethyl) ethyl benzoate, *m*-$H_5C_2OOCC_6H_4CH_2CH_2NH_2$	53.5*	Slotta and Kethur[38]
p-(2-Nitrovinyl)-methyl benzoate, *p*-$H_3COOCC_6H_4CH=CHNO_2$	*p*-(2-Aminoethyl) methyl benzoate, *p*-$H_3COOCC_6H_4CH_2CH_2NH_2$	52.2*	Slotta and Kethur[38]
p-(2-Nitrovinyl) ethyl benzoate, *p*-$H_5C_2OOCC_6H_4CH=CHNO_2$	*p*-(2-Aminoethyl) ethyl benzoate, *p*-$H_5C_2OOCC_6H_4CH_2CH_2NH_2$	53.5*	Slotta and Kethur[38]
2-(2-Nitrovinyl) phenanthrene,	2-(2-Aminoethyl) phenanthrene,	35-40	Mosettig and May[39]
3-(2-Nitrovinyl) phenanthrene,	3-(2-Aminoethyl) phenanthrene, 	50	Mosettig and May[39]
2-(2-Nitrovinyl) furane, 	2-Furanethylamine, 	91	Takamoto[40]

* Weighed as hydrochloride.

[38] Ber., **71**, 62 (1938).

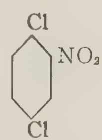
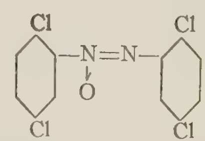
[39] J. Am. Chem. Soc., **60**, 2964 (1938).

[40] J. Pharm. Soc. Japan, **48**, 134 (1938).

TABLE XI.

Electrolytic Reduction of Nitro Compounds to Azoxy Compounds.

$$2RNO_2 + 6H^+ + 6F \xrightarrow[NaOH]{} RN{=}NR \text{ (Cathode)}$$
(with ↓O on the N=N)

Starting Material	Product	Yield % by Wt.	Investigators
m-Chloronitrobenzene, *m*-$ClC_6H_4NO_2$	*m, m'*-Azoxybischlorobenzene, *m, m'*-$ClC_6H_4N \rightarrow O$ / ClC_6H_4N (=)	80	Wipplinger[42]
p-Chloronitrobenzene, *p*-$ClC_6H_4NO_2$	*p, p'*-Azoxybischlorobenzene, *p, p'*-$ClC_6H_4N \rightarrow O$ / ClC_6H_4N (=)	85	Wipplinger[42]
p-Nitroanisole, *p*-$CH_3OC_6H_4NO_2$	*p, p'*-Azoxybisanisole, *p*-$CH_3OC_6H_4N \rightarrow O$ / $CH_3OC_6H_4N$ (=)	95	Gaumer[41]
p-Nitrophenetole, *p*-$C_2H_5OC_6H_4NO_2$	*p, p'*-Azoxybisphenetole, *p, p'*-$C_2H_5OC_6H_4N \rightarrow O$ / $C_2H_5OC_6H_4N$ (=)	94	Gaumer[41]
m-Nitrobenzonitrile, *m*-$O_2NC_6H_4CN$	*m, m'*-Azoxybisbenzonitrile, *m, m'*-NCC_6H_4N-NC_6H_4CN (with O ↑ on N)	30	Saame[42]
m-Nitrobenzonitrile, *m*-$O_2NC_6H_4CN$	*m, m'*-Azoxybisbenzamide, *m, m'*-$H_2NOCCC_6H_4N \rightarrow O$* / $H_2NOCCC_6H_4N$ (=)	80-90	Saame[42]
p-Dichloronitrobenzene, 	2, 2', 5, 5'-Tetrachloro-azoxybenzene, 	50	Wipplinger[42]

† CH_3OONH_4 electrolyte.
* Hydrolysis of nitrile.

[41] Dissertation, Univ. of Giessen (1901).
[42] Dissertation, Univ. of Giessen (1900).

TABLE XI (Continued).

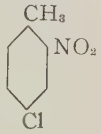
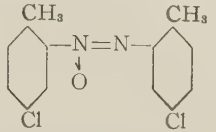
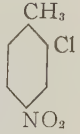
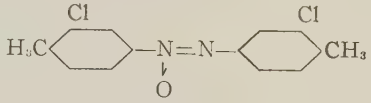
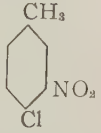
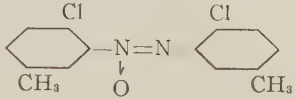
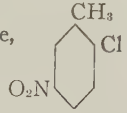
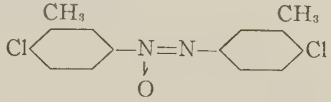
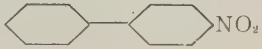
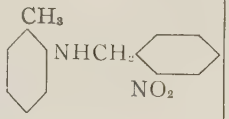
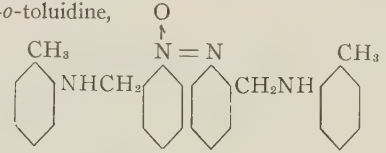
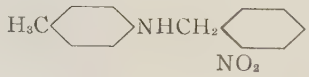
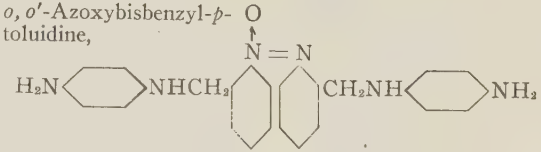
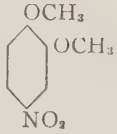
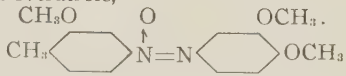
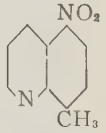
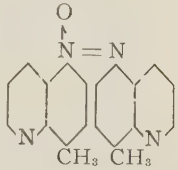
Starting Material	Product	Yield % by Wt.	Investigators
p-Chloro-*o*-nitrotoluene, 	*p*, *p*′-Dichloro-*m*, *m*′-azoxytoluene, 	85	Friedberger[42]
o-Chloro-*p*-nitrotoluene, 	*o*, *o*′-Dichloro-*p*-*p*′-azoxytoluene, 	90	Friedberger[42]
p-Chloro-*m*-nitrotoluene, 	4, 4′-Dichloro-3, 3′-azoxytoluene, 	62	Friedberger[42]
2-Chloro-5-nitrotoluene, 	2, 2′-Dichloro-5, 5′-azoxytoluene, 	85	Friedberger[42]
p-Nitrobiphenyl, 	*p*, *p*′-Azoxybisbiphenyl,	91	Koch[42]

TABLE XI (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
o-Nitrobenzylaniline, o-$C_6H_5NHCH_2C_6H_4NO_2$	*o, o'*-Azoxybisbenzyl aniline, *o, o'*-$C_6H_5NHCH_2C_6H_4N{=}O$ / $C_6H_5NHCH_2C_6H_4N$	17	Gaumer[41]
o-Nitrobenzyl-*o*-toluidine, 	*o, o'*-Azoxybisbenzyl-*o*-toluidine, 	11	Gaumer[41]
o-Nitrobenzyl-*p*-toluidine, 	*o, o'*-Azoxybisbenzyl-*p*-toluidine, 	55	Gaumer[41]
m-Nitroveratrole, 	*m, m'*-Azoxybisveratrole, 	98	Wille[43]
8-Methyl-5-nitroquinoline, 	8, 8'-Dimethyl-5, 5'-azoxybisquinoline, 	73	Zöckler[44]

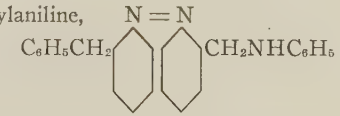
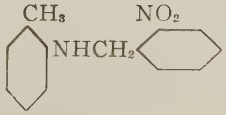
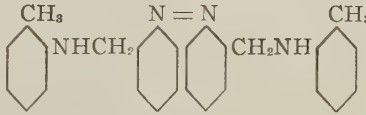
[43] Dissertation, Univ. of Giessen (1909).

[44] Dissertation, Univ. of Giessen (1903).

TABLE XII.

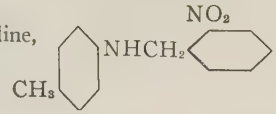
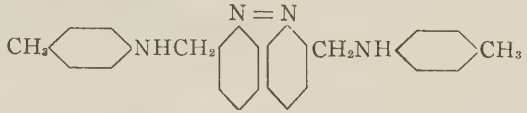
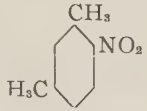
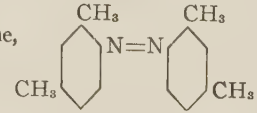
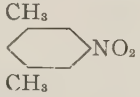
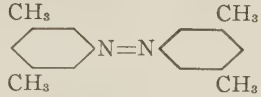
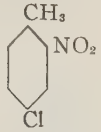
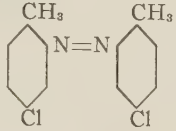
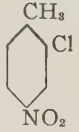
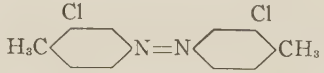
Electrolytic Reduction of Nitro Compounds to Azo Compounds.

$$2RNO_2 + 8H^+ + 8F \xrightarrow[NaOH]{} RN{=}NR \text{ (Cathode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
m-Chloronitrobenzene, *m*-$ClC_6H_4NO_2$	*m, m'*-Dichloroazobenzene, *m, m'*-$ClC_6H_4N{=}NC_6H_4Cl$	75	Wipplinger[42]
p-Chloronitrobenzene, *p*-$ClC_6H_4NO_2$	*p, p'*-Dichloroazobenzene, *p, p'*-$ClC_6H_4N{=}NC_6H_4Cl$	75	Wipplinger[42]
m-Nitrobenzonitrile, *m*-$NCC_6H_4NO_2$	*m, m'*-Azobisbenzamide,* *m, m'*-$H_2NOCC_6H_4N{=}NC_6H_4CONH_2$	80-90	Saame[42]
m-Nitrobenzonitrile, *m*-$NCC_6H_4NO_2$	*m, m'*-Azobisbenzonitrile, *m, m'*-$NCC_6H_4N{=}NC_6H_4CN$	30	Saame[42]
p-Nitrobenzonitrile, *p*-$NCC_6H_4NO_2$	*p, p'*-Azobisbenzamide, *p, p'*-$H_2NOCC_6H_4N{=}NC_6H_4CONH_2$	40	Saame[42]
o-Nitrobenzylaniline, *o*-$C_6H_4NHC_6H_4NO_2$	*o, o'*-Azobisbenzylaniline, 	68	Gaumer[41]
o-Nitrobenzyl-*o*-toluidine, 	*o, o'*-Azobisbenzyl-*o*-toluidine, 	58	Gaumer[41]

† CH_3OONH_4 electrolyte. * Hydrolysis of nitrile.

TABLE XII (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
o-Nitrobenzyl-*p*-toluidine, 	*o*, *o*′-Azobisbenzyl-*p*-toluidine, 	23	Gaumer[41]
p-Nitrobenzene sulfonic acid, p-$O_2NC_6H_4SO_2OH$	*p*, *p*′-Azobisbenzene sulfonic acid, p,p'-$HOO_2SC_6H_4N{=}NC_6H_4SO_2OH$	Nearly 100	Wohlfahrt[45]
4-Nitro-*m*-xylene, 	4, 4′-Azobis-*m*-xylene, 	95	Gaumer[41]
5 Nitro-*m*-xylene, 	5, 5′-Azobis-*m*-xylene, 	76-79	Fichter and Gunst[46]
p-Chloro-*o*-nitrotoluene, 	*p*, *p*′-Dichloro-*o*, *o*′-azobistoluene, 	82	Friedberger[42]
o-Chloro-*p*-nitrotoluene, 	*o*, *o*′-Dichloro-*p*, *p*′-azobistoluene, 	75	Friedberger[42]

[45] J. prakt. Chem., (2), 66, 554 (1902). [46] Helv. Chim. Acta, 22, 554 (1939).

TABLE XII (Continued).

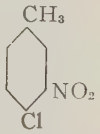
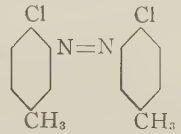
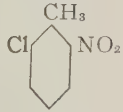
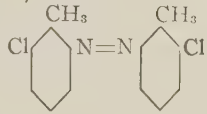
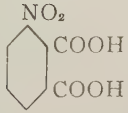
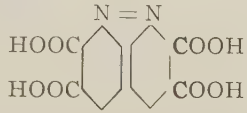
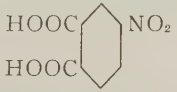
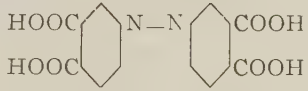
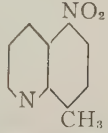
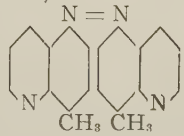
	Product	Yield % by Wt.	Investigators
p-Chloro-*m*-nitrotoluene, 	*p, p'*-Dichloro-*m, m'*-azobistoluene, 	50	Friedberger[42]
2-Chloro-5-nitrotoluene, 	2, 2'-Dichloro-5, 5'-azobistoluene, 	60	Friedberger[42]
3-Nitrophthalic acid, 	3, 3'-Azobisphthalic acid, 	83	Koch[42]
4-Nitrophthalic acid, 	4, 4'-Azobisphthalic acid, 	88	Koch[42]
8-Methyl-5-nitroquinoline, 	8, 8'-Dimethyl-5, 5'-azobisquinoline, 	60	Zöckler[44]

Table XIII.

Electrolytic Reduction of Nitro Compounds to Hydrazo Compounds.

$$2RNO_2 + 10H^+ + 10F \xrightarrow[\text{Alkali}]{} RNHNHR \text{ (Cathode)}$$

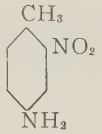
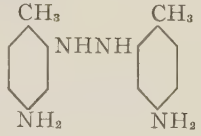
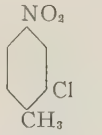
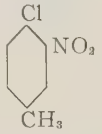
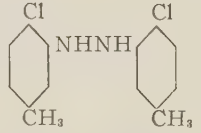
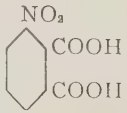
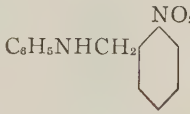
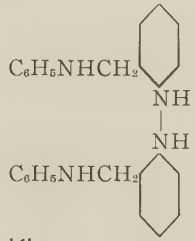
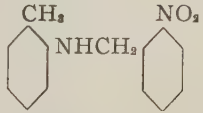
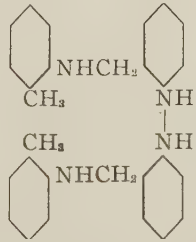
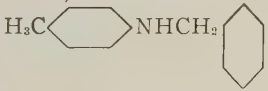
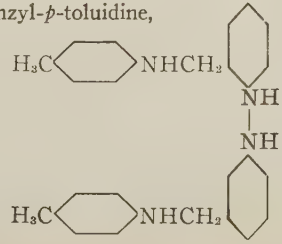
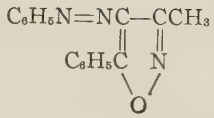
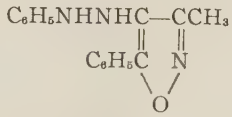
Starting Material	Product	Yield % by Wt.	Investigators
m-Nitro-*p*-toluidine, 	*m, m'*-Hydrazobis-*p*-toluidine, 	80	Gaumer[41]
o-Chloro-*p*-nitrotoluene, 	*o, o'*-Dichloro-*p, p'*-hydrazobistoluene,	76	Friedberger[42]
p-Chloro-*m*-nitrotoluene, 	*p, p'*-Dichloro-*m, m'*-hydrazobistoluene, 	50	Friedberger[42]
3-Nitrophthalic acid, 	3, 3'-Hydrazobisphthalic acid,	81	Koch[42]

TABLE XIII (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
o-Nitrobenzylaniline, 	*o, o'*-Hydrazobisbenzylaniline, 	70	Gaumer[41]
o-Nitrobenzyl-*o*-toluidine, 	*o, o'*-Hydrazobisbenzyl-*o*-toluidine, 	59	Gaumer[41]
o-Nitrobenzyl-*p*-toluidine, 	*o, o'*-Hydrazobisbenzyl-*p*-toluidine, 	60-65	Gaumer[41]

Electrolytic Reduction of Azo Compounds to Hydrazo Compounds.

$$RN{=}\dot{N}R + 2H + 2F \xrightarrow[NaOH]{} RNHNHR \text{ (Cathode)}$$

Wittig, Kleiner and Conrad[47] have shown that 3-methyl-5-phenyl-4-benzeneazoisoxazole  may be reduced electrolytically to 3-methyl-5-phenyl-4-β-phenylhydrazineisoxazole  in 70% yield.

[47] Ann., 469, 9 (1929).

Table XV.

Electrolytic Reduction of Nitramines and Nitrosamines to Hydrazines.

$$\begin{matrix} RNHNO_2 + 6H^+ + 6F \\ RNHNO + 4H^+ + 4F \end{matrix} \xrightarrow[H_2SO_4]{} RNHNH_2 \text{ (Cathode)}$$

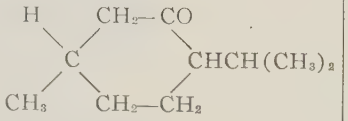
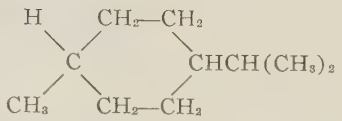
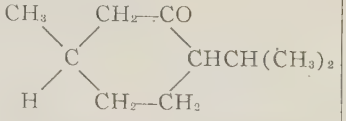
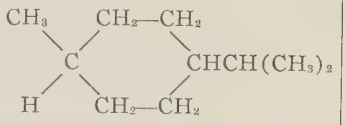
Starting Material	Product	Yield % by Wt.	Investigators
1-Methyl-3-nitrourea, $CH_3NHCONHNO_2$	4-Methylsemicarbazide, $CH_3NHCONHNH_2$	69*	Backer[48]
1-Methyl-1-nitrosourea, $ONNCONH_2$ CH_3	2-Methylsemicarbazide, $H_2NNCONH_2$ CH_3	95*	Backer[49]
Nitrosomethylaniline, NO $C_6H_5NCH_3$	As-Methyl-phenylhydrazine, C_6H_5 NNH_2 CH_3	85	Wells, Babcock and France[50]

* Weighed as benzalsemicarbazone.
[48] Rec. trav. chim., **34**, 194 (1915).
[49] *Ibid.*, **32**, 45 (1913).
[50] J. Am. Chem. Soc., **58**, 2630 (1936).

TABLE XVI.

Electrolytic Reduction of Carbonyl Groups to Methylene Groups.

$$RCOR + 4H^+ + 4F \xrightarrow[\text{strong acid}]{} RCH_2R \text{ (Cathode)}$$

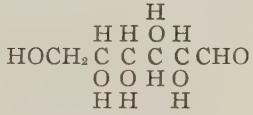
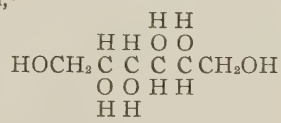
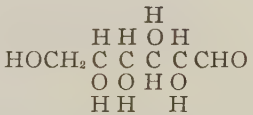
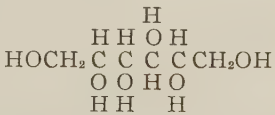
Starting Material	Product	Yield % by Wt.	Investigators
Diethylketone, $C_2H_5COC_2H_5$	*n*-Pentane, n-C_5H_{12}	70	Tafel and Zuber[51]
l-Menthone, 	l-Menthane, 	73	Keats[52]
dl-Isomenthone, 	Iso-Menthane, 	73	Keats[52]

[51] Z. Elektrochem., **17**, 972 (1911) Footnote.
[52] Keats, J. Chem. Soc., 2005 (1937).

TABLE XVII

Electrolytic Reduction of Carbonyl Compounds to Hydroxy Compounds.

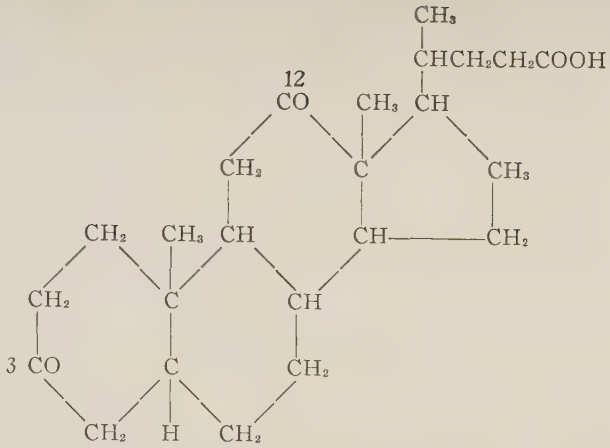
$$RCOR + 2H^+ + 2F \xrightarrow[\text{acid or alkali}]{} RCHOHR \text{ (Cathode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
Glucose, 	Mannitol,* 	16	Creighton[53]
Glucose, 	Sorbitol,* 	65 Total 81	Creighton[53]

* On an industrial scale.

[53] Trans. Electrochem. Soc., **75**, 289 (1939).

3, 12-Diketocholanic acid



has been reduced electrolytically in alkaline solution to 3-hydroxy-12-ketocholanic acid, 3-CHOH, in 40% yield weighed as ethyl ester by Schenck and Kirchhof.[54]

Electrolytic Reduction of Mixed Ketones to Pinacols.

$$2RCOCH_3 + 2H^+ + 2F \xrightarrow[\text{alkali}]{} \begin{matrix} CH_3 & CH_3 \\ RC & CR \\ O & O \\ H & H \end{matrix} \text{ (Cathode)}$$

Sperati[55] has carried out the reduction of acetophenone, $C_6H_5COCH_3$, to the 2, 3-diphenyl-2, 3-butanediol, $\begin{matrix} CH_3 & CH_3 \\ C_6H_5C & CC_6H_5 \\ O & O \\ H & H \end{matrix}$ (M.P. 116-117° C.) in 44% yield.

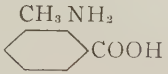
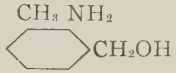
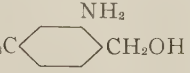
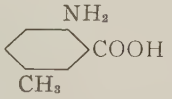
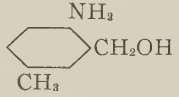
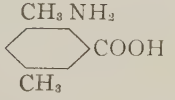
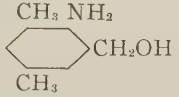
[54] Z. physiol. Chem., **163**, 125 (1927).

[55] Sperati, unpublished work, Univ. of Illinois (1939).

Table XVIII.

Electrolytic Reduction of Acids to Alcohols.

$$RCOOH + 4H^+ + 4F \xrightarrow[\text{strong acid}]{} RCH_2OH \text{ (Cathode)}$$

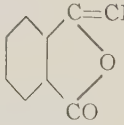
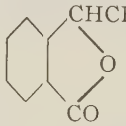
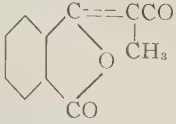
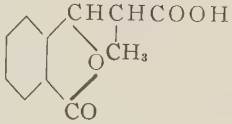
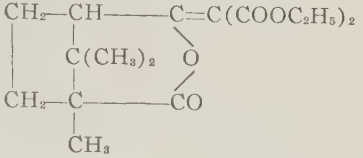
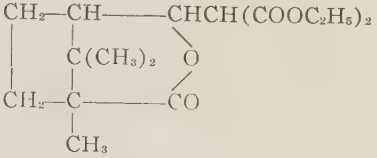
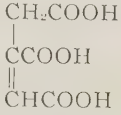
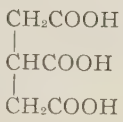
Starting Material	Product	Yield % by Wt.	Investigators
Benzoic acid, C_6H_5COOH	Benzyl alcohol, $C_6H_5CH_2OH$	85	Swann and Lucker[56]
o-Ethylbenzoic acid, *o*-$C_2H_5C_6H_4COOH$	*o*-Ethylbenzyl alcohol, *o*-$C_2H_5C_6H_4CH_2OH$	70	Mayer and English[57]
m-Ethylbenzoic acid, *m*-$C_2H_5C_6H_4COOH$	*m*-Ethylbenzyl alcohol, *m*-$C_2H_5CH_2OH$	65	Mayer and English[57]
3-Methylanthranilic acid, 	2-Amino-3-methylbenzyl alcohol, 	45	Mayer, Schäfer and Rosenbach[58]
4-Methylanthranilic acid,	2-Amino-4-methylbenzyl alcohol, 	65	Mayer, Schäfer and Rosenbach[58]
5-Methylanthranilic acid, 	2-Amino-5-methylbenzyl alcohol, 	76.5	Mayer, Schäfer and Rosenbach[58]
3, 5-Dimethylanthranilic acid, 	2-Amino-3, 5-dimethylbenzyl alcohol, 	73	Mayer, Schäfer and Rosenbach[58]

[56] Trans. Electrochem. Soc., **75**, 411 (1939).
[57] Ann., **417**, 69 (1918).
[58] Arch. Pharm., **267**, 581 (1929).

TABLE XIX.

The Electrolytic Reduction of Unsaturated Acids.

$$RCH{=}CHCOOH + 2H^+ + 2F \xrightarrow[\text{Acid or Alkali}]{} RCH_2CH_2COOH \text{ (Cathode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
o-Chlorocinnamic acid, *o*-$ClC_6H_4CH{=}CHCOOH$	*o*-Chlorohydrocinnamic acid, *o*-$ClC_6H_4(CH_2)_2COOH$	100	Meyer, Beer, and Lasch[59]
Phthalylacetic acid, 	Benzohydrylaceticcarboxylic acid anhydride, 	70	Lambooy[60]
Phthalylpropionic acid, 	α-Benzohydrylpropionic carboxylic acid anhydride, 	90-93	Lambooy[60]
Camphorylmalonic ester, 	Hydrocamphorylmalonic ester, 	85	Lapworth and Royle[61]
Aconitic acid, 	Tricarballylic acid, 	97	Siebert[62]

[59] Monatsch., **34**, 1667 (1913).
[60] Thesis, University of Illinois, 1939.
[61] J. Chem. Soc., **117**, 746 (1920).
[62] Z. Elektrochem., **44**, 768 (1938).

TABLE XX.

Electrolytic Reduction of Amides to Amines.

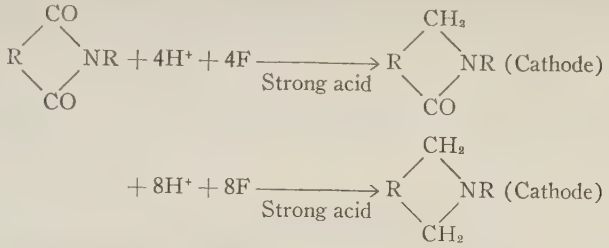
$$RCONR_2 + 4H^+ + 4F \xrightarrow[H_2SO_4]{} RCH_2NR_2 \text{ (Cathode)}$$

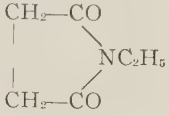
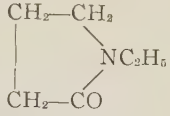
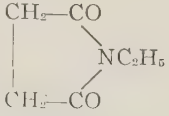
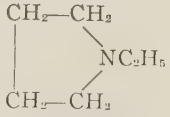
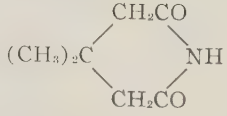
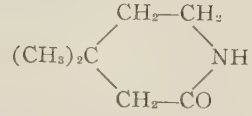
Starting Material	Product	Yield % by Wt.	Investigators
N, N-Dimethylvaleramide, $C_4H_9CON(CH_3)_2$	N, N-Dimethylamylamine, $C_5H_{11}N(CH_3)_2$	60	Swann[63]
N, N, N, N-Tetramethyladipamide, $(CH_2)_4[CON(CH_3)_2]_2$	1, 6-Dimethylaminohexane, $(CH_3)_2N(CH_2)_6N(CH_3)_2$	about 10	Prelog[64]
N, N, N, N-Tetramethylsuccinamide, $(CH_2CON(CH_3)_2)_2$	α-Dimethylaminobutyric acid,* $(CH_3)_2N(CH_2)_3COOH$	about 40	Prelog[64]
N, N, N, N-Tetramethyladipamide, $(CH_2)_4[CON(CH_3)_2]_2$	6-Dimethylaminocaproic acid,* $(CH_3)_2N(CH_2)_5COOH$	about 40	Prelog[64]

* Hydrolysis of amide.
[63] Unpublished work.
[64] Collection Czechoslov. Chem. Comm., 2, 716 (1930).

Table XXII.

Electrolytic Reduction of Imides of Dibasic Acids to Cyclic Amides and Amines.



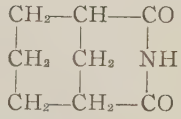
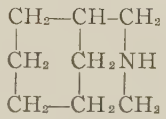
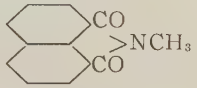
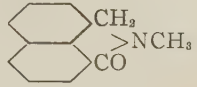
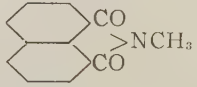
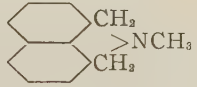
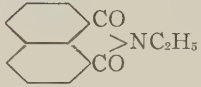
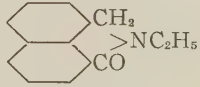
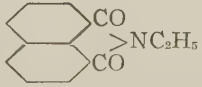
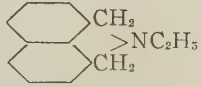
Starting Material	Product	Yield % by Wt.	Investigators
N-Ethylsuccinimide, 	1-Ethylpyrrolidone, 	69	Sakurai[65]
N-Ethylsuccinimide, 	1-Ethylpyrrolidine, 	18*	Sakurai[65]
Caronimide, 	4, 4-Dimethyl-2-piperidone, 	5	Menon and Simonsen[66]

* Weighed as double gold chloride.

[65] Bull. Chem. Soc. Japan, **11**, 42 (1936).

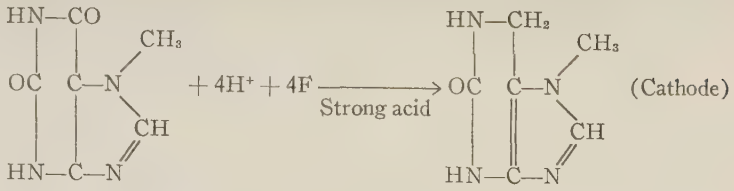
[66] J. Chem. Soc., 304 (1929).

TABLE XXII (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
3-Isogranatanine-2, 4-dione, 	3-Isogranatanine, 	17	Komppa[67]
N-Methylnaphthalimide, 	N-Methylnaphthalimidine, 	49	Sakurai[68]
N-Methylnaphthalimide, 	N-Methylbenzoisoquinoline, 	38	Sakurai[68]
N-Ethylnaphthalimide, 	N-Ethylnaphthalimidine, 	15	Sakurai[68]
N-Ethylnaphthalimide, 	N-Ethylbenzoisoquinoline, 	44	Sakurai[68]

[67] Ber., **65B**, 793 (1932).
[68] Bull. Chem. Soc. Japan, **14**, 173 (1939).

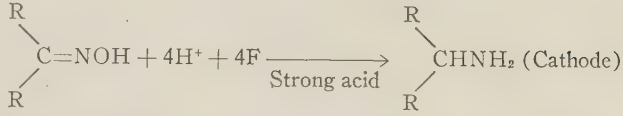
Electrolytic Reduction of Heteroxanthine to Desoxyheteroxanthine.



Tafel and Weinschenk[69] have carried out this reduction in 66% yield.

TABLE XXIII.

Electrolytic Reduction of Oximes to Amines.

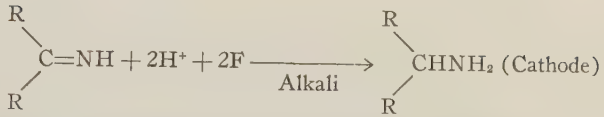


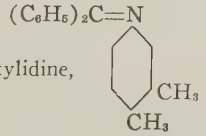
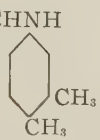
β-Ketovaleric acid oxime, $CH_3CH_2C(=NOH)CH_2COOH$, has been reduced electrolytically to β-aminovaleric acid, $CH_3CH_2CH(NH_2)CH_2COOH$, in 77% yield (as copper salt) by Anziegin and Gulewitsch.[70]

[69] Ber., **33**, 3370 (1900).
[70] Z. physiol. Chem., **158**, 35 (1926).

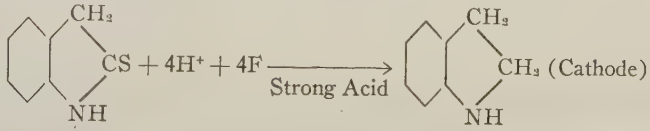
TABLE XXIIIa.

Electrolytic Reduction of Schiff's Bases.



Starting Material	Product	Yield % by Wt.	Investigators
Auramine, $[(CH_3)_2NHC_6H_4]_2C{=}NH$	Leucauramine, $[(CH_3)_2NHC_6H_4]_2CHNH_2$	90	Hoffmann[71a]
N-Benzohydrylideneaniline, $(C_6H_5)_2C{=}NC_6H_5$	N-Phenylbenzohydrylamine, $(C_6H_5)_2CHNHC_6H_5$	80	Hoffmann[71a]
N-Benzohydrylidene-*m*-toluidine, *m*-$(C_6H_5)_2C{=}NC_6H_4CH_3$	N-*m*-Tolylbenzohydrylamine, *m*-$(C_6H_5)_2CHNHC_6H_4CH_3$	70	Hoffmann[71a]
N-Benzohydrylidene-*p*-toluidine, *p*-$(C_6H_5)_2C{=}NC_6H_4CH_3$	N-*p*-Tolylbenzohydrylamine, *p*-$(C_6H_5)_2CHNHC_6H_4CH_3$	45	Hoffmann[71a]
N-Benzohydrylidene-3, 4-xylidine, 	N-3, 4-Xylylbenzohydrylamine, 	50-55	Hoffmann[71a]

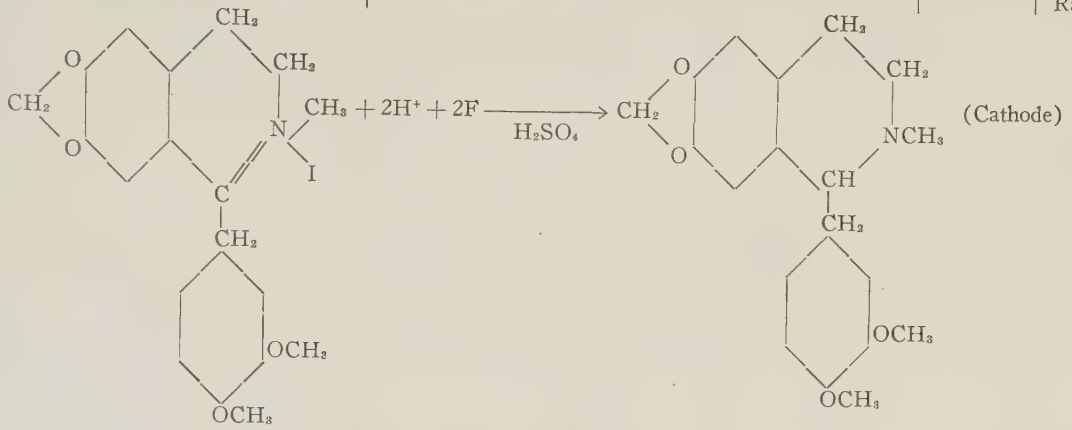
Electrolytic Reduction of Thio-isoximes to Imines.

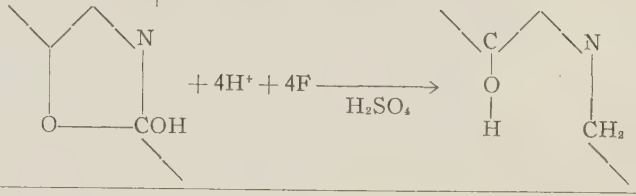


Sugasawa, Satoda and Yamagisawa[71] have carried out the reduction of 2(3)-indolethione to indoline in at least 63% yield.

[71a] Dissertation, Univ. of Giessen (1914). [71] J. Pharm. Soc. Japan, **58**, 139 (1938).

Starting Material	Product	Yield % by Wt.	Investigators
Reduction of Isoquinoline Nuclei to Tetrahydro Derivatives.			
3,4-Dihydro-6, 7-methylenedioxy-1-veratryliso-quinoline methiodide	1, 2, 3, 4-Tetrahydro-2-methyl-6, 7-methylenedioxy-1-veratrylisoquinoline	At least 48	Haworth, Perkin and Rankin[72]
Vomicine, $C_{22}H_{24}O_4N_2$	Vomicidine, $C_{22}H_{26}O_3N_2$	52	Wieland and Moyer[73]

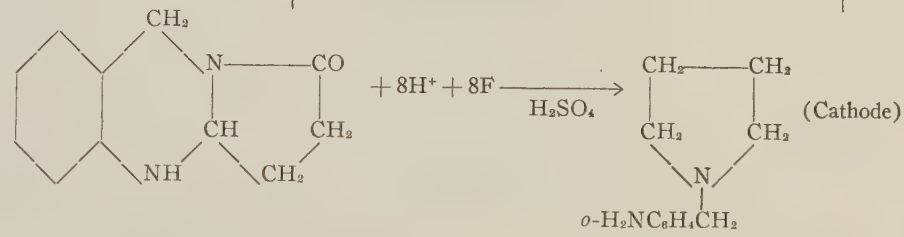


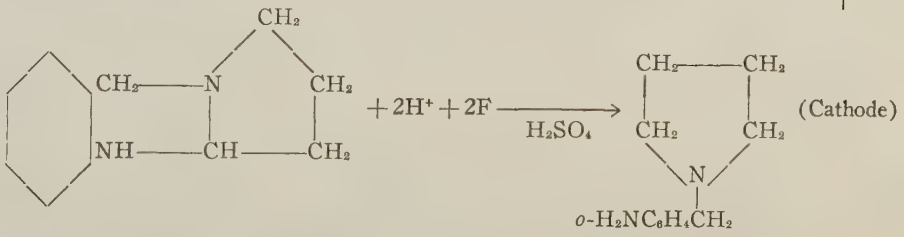


[72] J. Chem. Soc., **127**, 2020 (1925).
[73] Ann., **491**, 131 (1931).

TABLE XXIV (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
Scission of Carbon-Nitrogen Bond.			
9-Pegene-8-one	N-(*o*-Aminobenzyl)-pyrrolidine	56	Späth and Platzer[74]
Pegane	N-(*o*-Aminobenzyl)-pyrrolidine	90	Späth, Kuffner and Lintner[75]

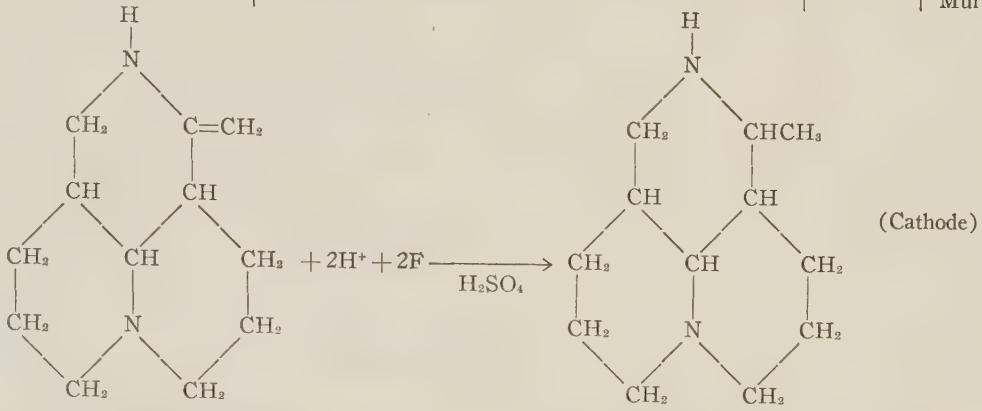




[74] Ber., 69, 392 (1936).
[75] *Ibid.*, 2058.

TABLE XXIV (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
Reduction of Carbon-Carbon Double Bond Adjacent to Nitrogen.			
α-Matrinidine	Dihydro-α-matrinidine	72	Tsuda and Murakami[76]



(Cathode)

[76] J. Pharm. Soc. Japan, **57**, 307 (1937).

TABLE XXIV (Continued).

Starting Material	Product	Yield % by Wt.	Investigators
Starting Material + $4H^+ + 4F \xrightarrow[H_2SO_4]{}$ Product (Cathode)			
Strychnine, $C_{21}H_{22}O_2N_2$	Tetrahydrostrychnine, $C_{21}H_{26}O_2N_2$	24	Clemo, Perkin and Robinson[77]
Strychnine, $C_{21}H_{22}O_2N_2$	Strychnidine, $C_{21}H_{24}ON_2$	70	Leuchs and Wegener[78]
Strychnine, $C_{21}H_{22}O_2N_2$	Tetrahydrostrychnine, $C_{21}H_{26}O_2N_2$	20	Leuchs and Wegener[78]
Brucine, $C_{21}H_{26}O_4N_2$	Brucidine, $C_{21}H_{28}O_3N_2$	47	Gulland, Perkin and Robinson[79]
Brucine, $C_{21}H_{26}O_4N_2$	Tetrahydrobrucine, $C_{21}H_{30}O_4N_2$	23	Gulland, Perkin and Robinson[79]
Brucine, $C_{21}H_{26}O_4N_2$	Brucidine, $C_{23}H_{28}O_3N_2$	50	Leuchs and Beyer[80]
Brucine, $C_{21}H_{26}O_4N_2$	Tetrahydrobrucine, $C_{23}H_{30}O_4N_2$	30	Leuchs and Beyer[80]
Starting Material + $2H^+ + 2F \xrightarrow[H_2SO_4]{}$ Product (Cathode)			
Methoxymethyldihydrobrucidine, $C_{25}H_{34}O_4N_2$	Methoxymethyltetrahydrobrucidine, $C_{25}H_{36}O_4N_2$	90	Gulland, Perkin and Robinson[79]
Starting Material + $8H^+ + 8F \xrightarrow[H_2SO_4]{}$ Product (Cathode)			
Constitution unknown, $C_{22}H_{33}O_4N$	Constitution unknown, $C_{22}H_{37}O_2N$	35‡	Schild[81]

[77] J. Chem. Soc., 1600 (1927).
[78] Ber., **63**, 2215 (1930).
[79] J. Chem. Soc., 1635 (1927).
[80] Ber., **64**, 2162 (1931).
[81] Ber., **69**, 78 (1936).
* Simultaneous reduction of carbonyl to methylene.
‡ Weighed as perchlorate.

TABLE XXV.

Electrolytic Reduction of Diazonium Compounds to Hydrazines.

$$RN{=}NCl + 4H^+ + 4F \xrightarrow[NaHSO_3]{} RNHNH_2$$

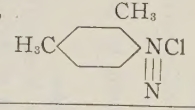
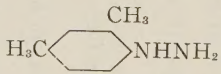
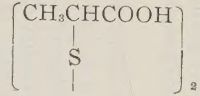
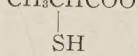
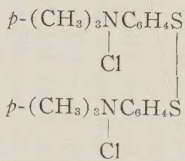
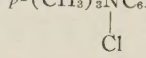
Starting Material	Product	Yield % by Wt.	Investigators
2, 4-Xylenediazonium chloride, 	2, 4-Xylylhydrazine, 	50*	Takayanagi[82]

TABLE XXVIII.

Electrolytic Reduction of Disulfides to Mercaptans.

$$RSSR + 2H^+ + 2F \xrightarrow[Acid]{} 2RSH \text{ (Cathode)}$$

Starting Material	Product	Yield % by Wt.	Investigators
α, α′-Dithiobispropionic acid, 	α-Mercaptopropionic acid, 	70	Larsson[83]
p-Dithiobistrimethylphenylammonium chloride, 	*p*-Mercaptotrimethylphenylammonium chloride, 	20	Schwarzenbach and Rudin[84]

* Weighed as hydrochloride. Yield based on *m*-xylidine.

[82] J. Chem. Soc. Japan, **57**, 64 (1936).

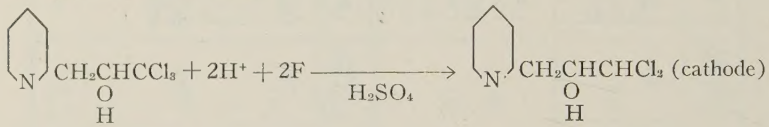
[83] Larsson Svensk Kem. Tid., **40**, 150 (1928).

[84] Helv. Chim. Acta, **22**, 371 (1939).

Addenda and Corrections to First Paper.[3]

The following preparation should be included in this paper.

Electrolytic Reduction of α-(Trichloromethyl)-2-pyridineëthanol to α-(Dichloromethyl)-2-pyridineëthanol.



Brand and Reuter[85] have carried out this reduction in about 50 per cent yield.

The yields in Table I and our own preparation in Table II are based on free acid. The rest are on total acid.

On Page 387* the name of the last product should be eicosane.

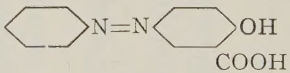
On Page 388 the date of reference number 11 should be 1925.

On Page 391 the acid is dilute HCl.

On Page 395 the H and OH attached to the α carbon atom in the formula for glucose should be reversed.

On Page 397 the date of reference number 36 should be 1929. *o*-Nitrophenol was reduced in alkaline solution. The latter part of the formula in the column of products third from the bottom of the page should read —NHOCCH₃.

On Page 406 Azo Salicylic Acid should be Benzene Azo Salicylic Acid. The formula should be



This reduction is carried out with $TiCl_3$ which is regenerated electrolytically in a separate cell.

On Page 407 the name of the starting material at the bottom of the page should read α-(3, 4-Dimethoxy-phenyl)-α-acetoxy-β-nitropropanol.

On Page 417 the electrolytic reduction of cinnamic acid is carried out in alkaline solution.

On Page 418 the yield of N-ethyl-*o*-toluidine should be 67.5 per cent. The product was weighed as nitrosamine.

On Page 419, *p*-toluamine should be *p*-tolubenzylamine.

On Page 423, N-methyl dihydroisoindole should be N-methyl phthalimidine.

On Page 425 the bond of the lower nitrogen atom to the carbon atom on its right in the formula for desoxycaffeine should be double.

On Page 429 the reference 112 should refer to Speyer and Popp.

On Page 435 the CH groups in the upper right part of the product should be part of the rings.

[85] Ber., **72**, 1668 (1939).

* The page numbers refer to the preprint of this paper (Preprint 69-36). The corresponding page numbers of Volume 69 are as follows:

	Preprint	Volume		Preprint	Volume		Preprint	Volume
Page	387	289	Page	406	308	Page	419	321
Page	388	290	Page	407	309	Page	423	325
Page	391	293	Page	417	319	Page	425	327
Page	395	297	Page	418	320	Page	429	331
Page	397	299				Page	435	337

Resumen del artículo: "Preparaciones Electro-orgánicas. II."

Esta lista de reacciones electro-orgánicas sintéticas completa a una anterior.[3] Los grupos principales de reacciones son: Parte 1a, acoplamiento; 2a, oxidación; 3a, reacciones con los halógenos (incluyendo la oxidación de azúcar, catalizada por los halógenos); y 4a, reducción.